UPKAR'S

# Objective Mechanical Engineering

[Railway & Other Engineering (Diploma) Competitive Exams.]

P. K. Mishra

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# Mechanical Engineering

**[For competitive selection examinations of Railway Service, Engineering (diploma) level, State Public Service Commissions, C.P.W.D., P.W.D., Coal India, Irrigation Departments and other equivalent services.]**

*By*

*Pramod Kumar Mishra*

*&*

*Kumar Sundram*

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# PREFACE

Success in examinations depends on proper planning of studies and appropriate selection of study materials. The pattern of examinations has become tough. This is the reason why a right choice of study materials plays a very important role. This book cover thoroughly all the basics of the whole course as well as present to the examinee a wide spectrum of the multiple choice questions having a huge variety. The author has made a sincere attempt in this direction in the present book. Various unique features of the book are as under :

- A brief review of concepts at a glance covering all fundamentals and important conclusions is given at the start of every chapter.
- Chapters are classified under different units.
- Multiple choice questions in every chapter are arranged in a systematic and sequential way covering the whole text and spectrum of the chapter.
- Answers are provided at the end of every chapter.
- **Model Test Papers** covering the whole syllabus are also provided at the end of the book again with their answers. These papers will prove to be fit for examination and will provide a chance to students in assessing their level of preparation.

The present book is self-sufficient in all respects.

I am thankful to my wife Mrs. Rita Mishra who has put hard labour in reading the proofs thoroughly and pointing out errors and omissions. My sincere thanks are also due to publisher Mr. Mahendra Jain who gave me a chance to write this type of books. This edition is a nice form.

Although all attempts have been made to avoid errors and printing mistakes, yet omissions are a human weakness and, therefore, constructive suggestions, modifications and errors brought to my notice will be highly appreciated and incorporated in the next edition.

**—Pramod Kumar Mishra**

**&**

**Kumar Sundram**

# CONTENTS

# Mechanical Engineering

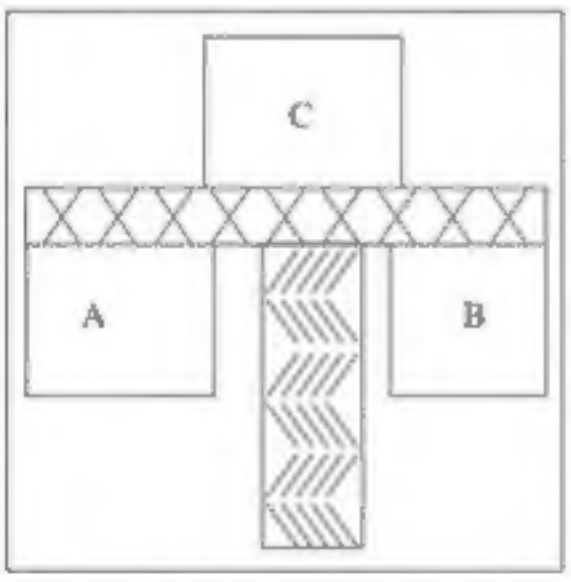
# 1 THERMODYNAMICS

## Thermodynamics

The study of heat and its transformation to mechanical energy is called THERMODYNAMICS. It is the science that deals with the relations between heat, work and properties of systems. It is based on the law of conservation of energy and the fact that heat flows naturally from a hot body to a cold body and not the other way around.

## Zeroth Law of Thermodynamics

This law states that "Two bodies or systems that are in thermal equilibrium with a third body are in thermal equilibrium with each other". Two bodies A and B are in thermal equilibrium if they are at the same temperature. One way to determine if two bodies A and B are in thermal equilibrium would be to make use of a third body C in thermal equilibrium by a thermometer. If the thermometer reads the same temperature for bodies A and B, then bodies A and B are in thermal equilibrium with each other.




## First Law of Thermodynamics

When the law of energy is applied to thermal system then we call it the first law of thermodynamics. This law states that, "Whenever heat is added to a system, it transforms to an equal amount of some other form/forms of energy".

Clausius stated the first law or thermodynamics in the form as—

$$dH = dU + dW$$

Where $dH$ = quantity of heat supplied or taken away from the system

$dU$ = change in internal energy of the system

$dW$ = External work done

The other form of first law is

$$dQ \propto dW$$

$$dQ = \frac{dW}{J}$$

$$\Rightarrow \quad \int dQ = \int \frac{dW}{J}$$

## Second Law of Thermodynamics

**Kelvin's Law**—It is impossible by means of inanimate material agency to derive mechanical effect from any portion of the matter by cooling it below the temperature of the coldest of the surrounding objects.

**Planck's Law**—It is impossible to construct an engine which working in a complete cycle, will produce no effect other than the raising of a weight and the cooling of a heat reservoir.

**Kelvin-Planck Law**—It is impossible to construct an engine that operating in a cycle, will produce no effect other than the extraction of heat from a reservoir and the performance of an equivalent amount of work.

**Clausius' Law**—It is impossible for a self-acting machine, unaided by an external agency to convey heat from one body to another at a higher temperature or heat can't of itself pass from a colder to a warmer body.

## Third Law of Thermodynamics

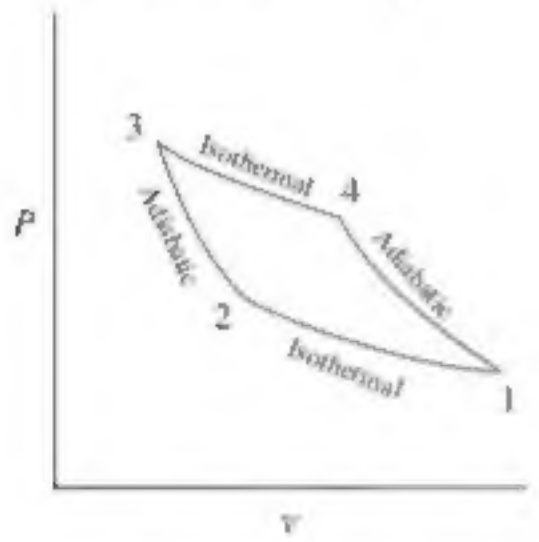
Third Law of thermodynamics states as follows :

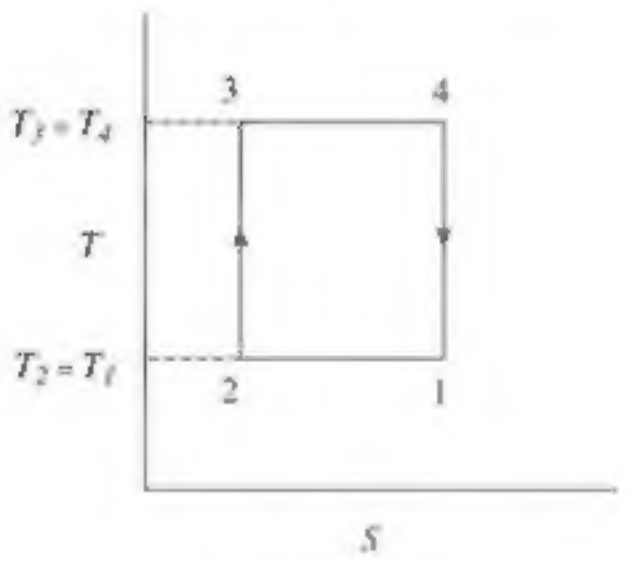
"The entropy of perfect crystal at absolute zero temperature is zero". However, if the substance is not a perfect crystal like glass or solid solution, this entropy will have a finite value.

## Power Cycle

(i) **Carnot Cycle**—In a Carnot cycle, the working substance is subjected to a cyclic operation consisting of two isothermal and two reversible adiabatic or isentropic operations.

$$\text{Efficiency } (\eta)_{\text{carnot}} = \frac{T_3 - T_1}{T_3}$$



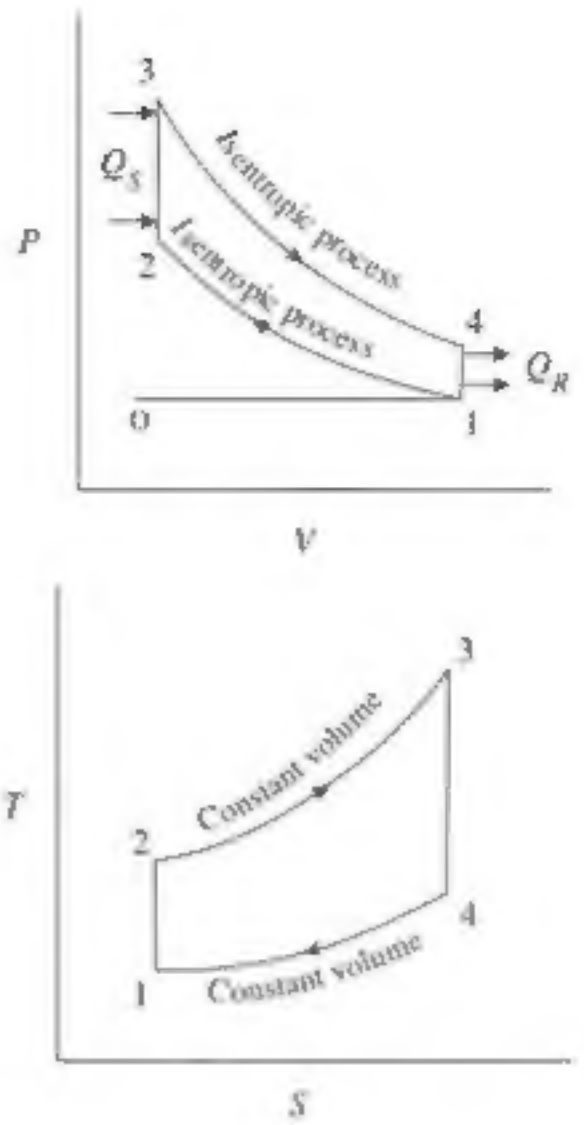




**Carnot Cycle**

(ii) **Otto Cycle**—The ideal otto cycle consists of two constant volume and two reversible adiabatic or isentropic processes. It is also known as constant volume cycle. This cycle is taken as a standard of comparison for internal combustion engines. These days, many gas, petrol and many of the oil engines run on this cycle.

$$\text{Efficiency } (\eta)_{\text{otto}} = 1 - \frac{T_4 - T_1}{T_3 - T_2}$$

$$(\eta)_{\text{otto}} = 1 - \frac{1}{r^{(\gamma-1)}}$$

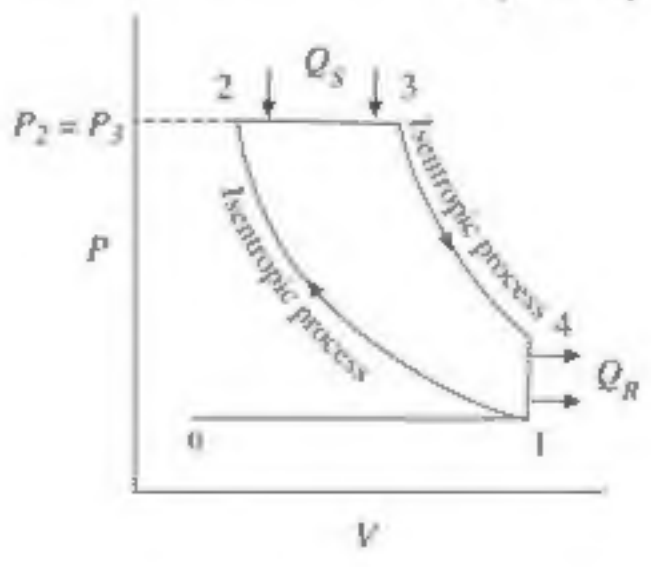


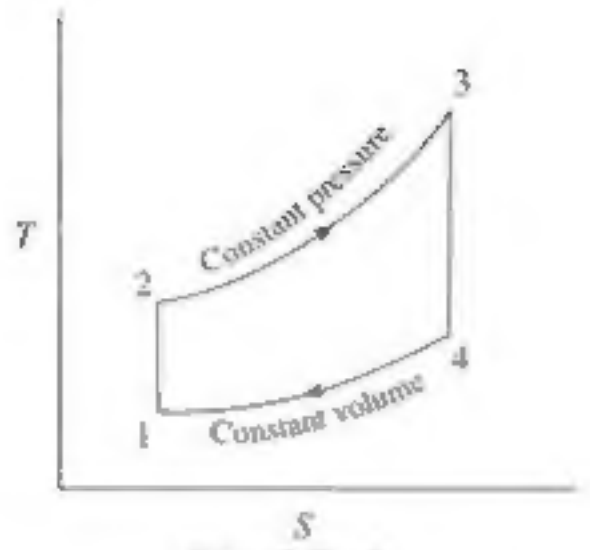

**Otto Cycle**

Hence the efficiency of otto cycle depends on compression ratio ($r$) only. In actual practice '$r$' cannot be increased beyond a value of 7 or so.

(iii) **Diesel Cycle**—The ideal diesel cycle consists of two reversible adiabatic or isentropic, a constant pressure and a constant volume processes. This is an important cycle on which all the diesel engines work. It is also known as constant pressure cycle as heat is received at a constant pressure.

$$\text{Efficiency } (\eta)_{\text{Diesel}} = 1 - \frac{1}{\gamma}\left(\frac{T_4 - T_1}{T_3 - T_2}\right)$$



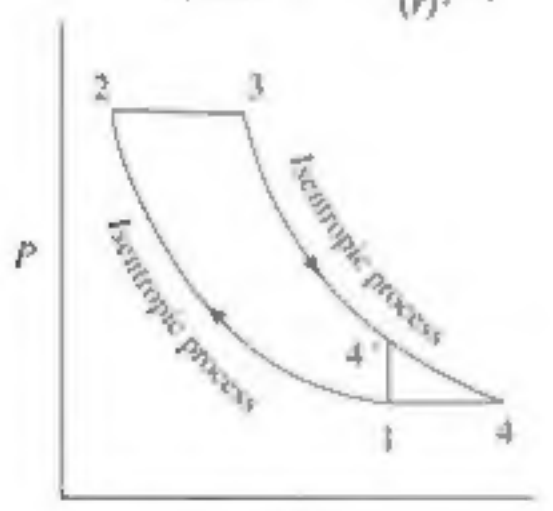



**Diesel Cycle**

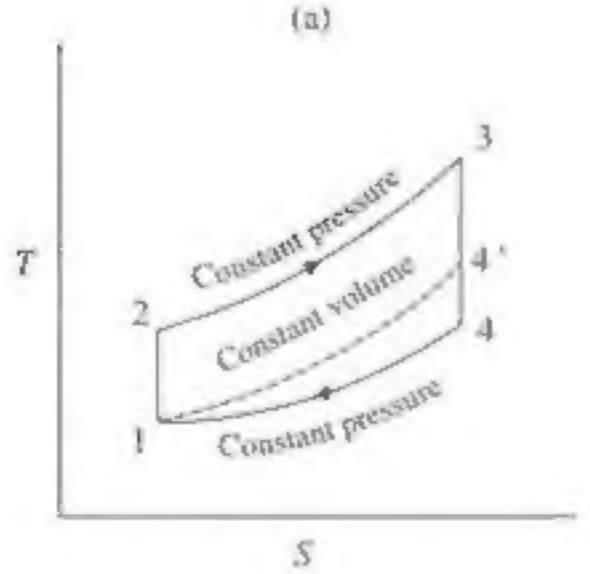
(iv) **Joule's Cycle**—It consists of two constant pressure and two reversible adiabatic or isentropic processes. The efficiency of the Joule's cycle is lower than Carnot efficiency. The reversed Joule cycle is known as Bell Coleman cycle or Brayton cycle and is applied to refrigerators, where air is used as a refrigerant.

$$\text{Efficiency } (\eta)_{\text{Joule}} = 1 - \frac{T_4 - T_1}{T_3 - T_2}$$

Or $$(\eta)_{\text{Joule}} = 1 - \frac{1}{(r)^{\gamma-1}}$$




(a)

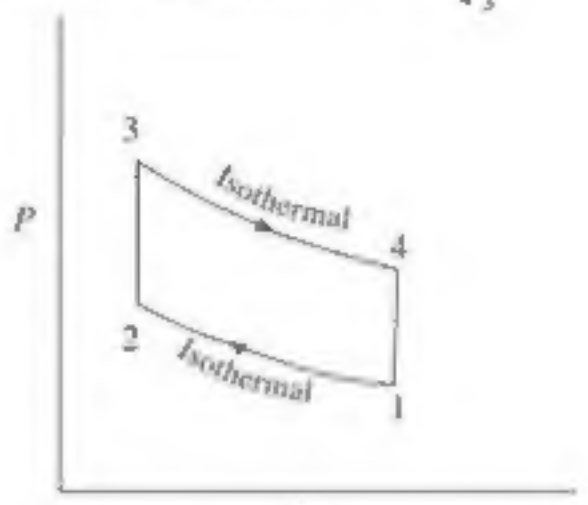


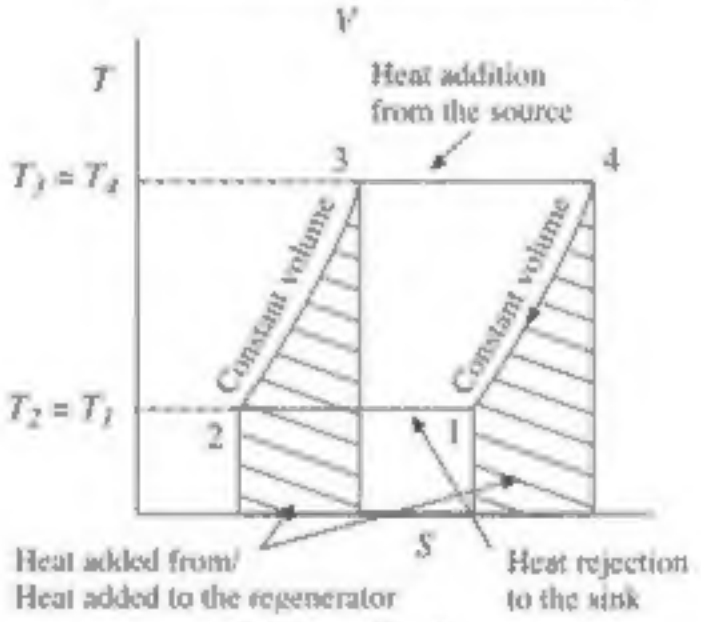

(b)

**Brayton Cycle**

(v) **Stirling Cycle**—It consists of two isothermal and two constant volume processes. The efficiency of Stirling cycle is same as that of Carnot cycle. This is due to the fact that the cycle is reversible, and all reversible cyclic have the same efficiency.

$$\text{Efficiency } (\eta)_{\text{Stirling}} = \frac{T_3 - T_1}{T_3}$$

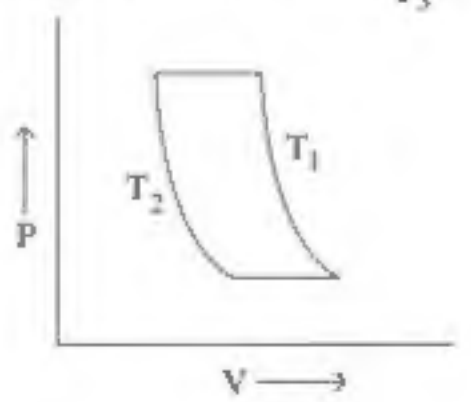



**Stirling Cycle**

(vi) **Ericsson Cycle**—It consists of two isothermal and two constant pressure processes. It is made thermodynamically reversible by the action of a regenerator. This cycle is used these days in the manufacture of closed-cycle type gas turbines. The efficiency of the Carnot cycle is same as that of Carnot efficiency *i.e.*,

$$\text{Efficiency } (\eta)_{\text{Ericsson}} = \frac{T_3 - T_1}{T_3}$$



# Thermometry

An instrument used for the measurement and comparison of temperature is called a thermometer. The branch of heat which deals with the study of thermometers, *i.e.* art of measuring temperature is called thermometry.

## Kinds of Thermometers

(1) (a) Liquid thermometers → Celcius, Fahrenheit, Reumer

(b) Alcohol

(2) Gas thermometers → Constant Pressure, Constant Volume

(3) Electrical resistance thermometers (Platinum resistance thermometers)

(4) Thermo couple thermometers (Based on seebeck effect)

(5) Total radiation thermometers (Pyrometers) (measure high temperature)

(6) Absolute scale thermometer (Kelvin scale)

## Thermometer Scale

In any thermometer there is an upper fixed point (U.F.P.) and a lower fixed point (L. F P ). The difference of U.F.P and L.F.P is known as fundamental interval (F.I )

$$\text{F.I} = \text{U.F.P} - \text{L.F.P}$$

For any thermometer

$$\frac{\text{Reading} - \text{L.F.P.}}{\text{U.F.P.} - \text{L.F.P.}} = \text{a constant}$$

$$\frac{C-0}{100-0} = \frac{F-32}{212-32}$$

$$= \frac{R-0}{80-0} = \frac{K-273}{373-273} = \frac{R_a-492}{672-492}$$

Here, C = Celcius Scale (Centigrade)
F = Fahrenheit Scale
R = Reumer Scale
K = Kelvin Scale
$R_a$ = Rankin Scale

## Basic Principle of Thermometers

**Specific Heat**—The heat required by a unit mass of a substance to raise its temperature by one degree is called the specific heat of the substance. It is also called the heat capacity of the substance In S.I. system, the unit of specific heat is J/kg°K and in M.K.S. units it is kcal/kg°C.

**Specific Volume** – It is defined as the volume per unit mass and may be expressed in $m^3$/kg. It is reciprocal of density

$v = \frac{1}{\rho}$, where $v$ is the specific volume.

Any property of substance which depends upon temperature is used in making thermometers

$$T \propto x$$

(where $x$ = any property of substance)

$$T_1 = Kx_1$$

$$T_2 = Kx_2$$

$$\Rightarrow \quad \frac{T_2}{T_1} = \frac{x_2}{x_1}$$

$$\text{or,} \quad \boxed{T_2 = T_1 \frac{x_2}{x_1}}$$

Here $T_1$ is taken as standard temperature. In thermometry triple point of water (273.16 Kelvin) is taken as standard temperature of thermometry.

$$T = 273.16 \frac{x_2}{x_1}$$

(a) For constant volume gas thermometers

$$T = 273{\cdot}16 \frac{P}{P_{273{\cdot}16}} \qquad P \rightarrow \text{Pressure}$$

(b) For constant pressure gas thermometers

$$T = 273{\cdot}16 \frac{V}{V_{273{\cdot}16}} \qquad V \rightarrow \text{Volume}$$

(c) For electric resistance thermometer

$$T = 273{\cdot}16 \frac{R}{R_{273{\cdot}16}} \qquad R \rightarrow \text{Resistance}$$

(d) For thermocouple thermometer

$$T = 273{\cdot}16 \frac{E}{E_{273{\cdot}16}} \qquad E \rightarrow \text{e.m.f}$$

**Temperature Measurement**—Let there be any property of a substance whose value at 0°C is $x_0$ and $t$°C is $x_t$ then

$$(x_t - x_0) \propto x_0 \qquad \text{(initial value)}$$

$$\propto t \qquad \text{(change in temperature)}$$

$$(x_t - x_0) = \alpha\, x_0\, t$$

$$\Rightarrow \quad \alpha = \frac{x_t - x_0}{x_0\, t} \qquad \ldots(i)$$

$$\text{and} \quad x_{100} = x_0 + x_0\, \alpha \times 100$$

$$\therefore \quad \alpha = \frac{x_{100} - x_0}{x_0 - 100} \qquad \ldots(ii)$$

From (i) and (ii)

$$t = \frac{x_t - x_0}{x_{100} - x_0} \times 100$$

(a) For constant volume gas thermometer

$$t = \frac{P_t - P_0}{P_{100} - P_0} \times 100$$ P → Pressure

(b) For constant pressure gas thermometer

$$t = \frac{V_t - V_0}{V_{100} - V_0} \times 100$$ V → Volume

(c) For electric resistance thermometer

$$t = \frac{R_t - R_0}{R_{100} - R_0} \times 100$$ R → Resistance

(d) For thermocouple thermometer

$$t = \frac{E_t - E_0}{E_{100} - E_0} \times 100$$

E → Electromotive force

| Scale | L.F.P. | U.F.P. | F.I. |
|---|---|---|---|
| Celcius | 0°C | 100°C | 100 |
| Fahrenheit | 32°F | 212°F | 180 |
| Reumer | 0°R | 80°R | 80 |
| Kelvin | 273K | 373K | 100 |
| Rankin | 492°$R_a$ | 672°$R_a$ | 180 |

## Gas Laws

(i) **Boyle's Law**—At constant temperature the volume of a given mass of a gas varies inversely as its absolute pressure.

$$V \propto \frac{1}{P}$$

$$PV = \text{Constant}$$

(ii) **Charle's Law**—At constant pressure, the volume of a given mass of a gas varies directly with temperature.

$$V \propto T$$

$$\frac{V}{T} = \text{Constant}$$

(iii) **Joule's Law**—This law states that the internal energy of a given quantity of a gas depends only on the temperature.

$$dE = m \times C_v \times dT$$

(iv) **Regnault's Law**—This law states that the two specific heats $C_v$ and $C_p$ of a gas do not change with the change of temperature and pressure.

(v) **Avogadro's Law**—According to this law equal volumes of different perfect gases at the same temperature and pressure contain equal number of molecules.

## Fuels

Fuels may be chemical or nuclear. Here we consider chemical fuels

"A chemical fuel is a substance which releases heat energy on combustion".

Fuels may be classified as—

1. They occur in nature called primary fuels or are prepared called secondary fuels.
2. They are in solid, liquid and gaseous states

### Requirements of a Good Quality Fuel

(A) It should have a low ignition point.
(B) It should have high calorific value.
(C) It should not produce harmful gases.
(D) It should produce least quantity of smoke and gases
(E) Once it is ignited, it should freely burn with high efficiency
(F) It should be easy to store.
(G) It should be economical
(H) It should be convenient for transportation.

### Calorific Value of Fuels

The heat value of a solid or liquid fuel can be defined as the amount of heat given out by the complete combustion of 1 kg of fuel. It is expressed by the term kJ/kg. The calorific value of gaseous fuel is expressed in terms of $kJ/m^3$ at a specified temperature and pressure.

There are two types of calorific value of fuels :

1 Higher or Gross Calorific Value

2 Lower or Net Calorific Value

**1. Higher Calorific Value**—The amount of heat obtained by the complete combustion of 1 kg of a fuel, when the products of its combustion are cooled down to the temperature of supplied air

(usually taken as 15°C), is called the higher calorific value of fuel. The higher calorific value of the fuel can be determined by the Dulong's formula *i.e.* H.C.V. 33,800 C + 144000 Hz + 92705 kJ/kg.

**2. Lower Calorific Value**—The lower calorific value or net calorific value is the heat released when water vapour in the products of combustion is not condensed and remains in the vapour form.

L.C.V. = H.C.V. – $m_s$ × 2466 kJ/kg

= H.C.V. – 9Hz × 2466 kJ/kg

[$\because m_s = 9Hz$]

| Types of fuel | Natural (Primary) | Prepared (Secondary) |
|---|---|---|
| Solid | Wood, peat, lignite coal | Coke, charcoal, briquettes |
| Liquid | Petroleum | Gasoline, kerosene, fuel oil, alcohol, benzol, shale oil. |
| Gaseous | Natural gas | Petroleum gas, producer gas, coal gas, coke-oven gas, Blast furnace gas, carburetted gas, sewer gas |

**Products of Petroleum Refining Process**

| S. N. | Fraction | App. Boiling Range, °C | Remarks |
|---|---|---|---|
| 1. | Fuel gas | –160 to –44 | Methane, ethane and some propane used as refinery fuel |
| 2. | Kerosene Middle distillate | 200 to 300 | Domestic, aviation fuels. |
| 3. | Light Gas Oil Middle distillate | 200 to 315 | Diesel fuels, furnace fuel oil |
| 4. | Propane | –40 | LPG |
| 5. | Butane | –12 to 30 | Blended with motor gasoline to increase its volatility |
| 6. | Vacuum gas oil | 425 to 600 | Feed for catalytic cracking |
| 7. | Heavy gas oil | 315 to 425 | Feed for catalytic cracking |
| 8. | Pitch | > 600 | Asphalts, heavy fuel oil |
| 9. | Light Naphtha | 0 to 150 | Motor gasoline for catalytic reforming |
| 10. | Heavy Naphtha | 150 to 200 | Catalytic reforming fuel, blended with light gas oil to form jet fuels. |

## Combustion of Fuels

**Carbon**—

(i) $C + O_2 = CO_2$

1 kg (Carbon) + $\frac{8}{3}$ kg (Oxygen)

= $\frac{11}{3}$ kg (Carbon dioxide)

(ii) $2C + O_2 = 2CO$

2 mol + 1 mol = 2 mol

1 mol + $\frac{1}{2}$ mol = 1 mol

24 + 32 = 56

1 kg (Carbon) + $\frac{4}{3}$ kg (Oxygen)

= $\frac{7}{3}$ kg (Carbon monoxide)

(iii) **Carbon monoxide**—

$2C + O_2 = 2CO_2$

2 vol + 1 vol = 2 vol

1 vol + $\frac{1}{2}$ vol = 1 vol

56 + 32 = 88

1 kg (Carbon) + $\frac{4}{7}$ kg (Oxygen)

= $\frac{11}{7}$ kg (Carbon dioxide)

(iv) **Sulphur**—

$S + O_2 = SO_2$

1 mol + 1 mol = 1 mol

32 + 32 = 64

1 kg (Sulphur) + 1 kg (Oxygen)

= 2 kg (Sulphur dioxide)

(v) **Hydrogen**—

$2H_2 + O_2 = 2H_2O$

1 vol + $\frac{1}{2}$ vol = 1 vol

4 + 32 = 36

1 kg (Hydrogen) + 8 kg (Oxygen)

= 9 kg (Water)

**Air Fuel Ratio (AFR)** – The air fuel ratio is the most common reference term used for mixtures in internal combustion engines. It is the ratio between the mass of air and the mass of fuel, in the fuel-air mixtures at any given moment For pure octane the Stoichiometric mixture is approximately 14·7 : 1 or λ of 1·00 exactly. In naturally aspirated engines powered by octane, maximum power is frequently reached at AFRs ranging from 12·5 – 13·3 : 1 or of λ 0·85 – 0·901 or AF = mass of Air/mass of fuel

**Fuel Air Ratio (FAR)** — It is commonly used in the gas turbine industry as well as government studies of internal combustion engine and refers to the ratio of fuel to the air, it is 1/AFR

# OBJECTIVE QUESTIONS

1. For isothermal expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is equal to—

   (A) $-\gamma^{1/2}\frac{\Delta V}{V}$ (B) $-\frac{\Delta V}{V}$

   (C) $\gamma\frac{\Delta V}{V}$ (D) None of these

2. The gas law $\frac{PV}{T}$ = constant, is true for—
   (A) Isothermal changes only
   (B) Adiabatic changes only
   (C) Both isothermal and adiabatic changes
   (D) Neither isothermal nor adiabatic changes

3. Air in a cylinder is suddenly compressed by a piston with the passage of time—
   (A) The pressure decreases
   (B) The pressure increases
   (C) The pressure may remain constant
   (D) The pressure may increase or decrease depending upon the nature of gas

4. The work done in an adiabatic change on a particular gas depends upon only—
   (A) Change in value
   (B) Change in pressure
   (C) Change in temperature
   (D) None of the above

5. The work done in an isothermal expansion of a gas depends upon—
   (A) Temperature
   (B) Expansion ratio only
   (C) Both temperature and expansion ratio
   (D) Neither temperature nor expansion ratio

6. The first law of thermodynamics is concerned with the conservation of—
   (A) Number of molecules
   (B) Temperature
   (C) Energy
   (D) Number of moles

7. A Carnot engine works between a hot reservoir at temperature $T_1$ and a cold reservoir at temperature $T_2$. To increase the efficiency—
   (A) $T_1$ and $T_2$ both should be increased
   (B) $T_1$ and $T_2$ both should be decreased
   (C) $T_1$ should be decreased and $T_2$ increased
   (D) $T_1$ should be increased and $T_2$ decreased

8 Which of the following is an intensive property of a thermodynamic system ?
   (A) Volume (B) Temperature
   (C) Mass (D) Energy

9 Which of the following is the extensive property of a thermodynamic system ?
   (A) Pressure (B) Volume
   (C) Temperature (D) Density

10 The temperature at which the volume of a gas becomes zero is called—
   (A) Absolute scale temperature
   (B) Absolute zero temperature
   (C) Absolute temperature
   (D) None of the above

11 The unit of energy in SI system is—
   (A) Joule (J) (B) Joule metre (Jm)
   (C) Watt (W) (D) Joule/metre (J/m)

12. One watt is equal to—
   (A) 1 Nm (B) 1 N/mm
   (C) 10 N/s (D) 1000 Nm/s

13. One joule (J) is equal to—
    (A) 1 Nm (B) K Nm
    (C) 10 Nm/s (D) 10 K Nm/s
14. The heating and expanding of a gas is called—
    (A) Thermodynamic system
    (B) Thermodynamic cycle
    (C) Thermodynamic process
    (D) Thermodynamic law
15. Which of the following statement is correct ?
    (A) The slope of vaporisation curve is always negative
    (B) The slope of vaporisation curve is always positive
    (C) The slope of sublimation curve is negative for all pure substances
    (D) The slope of fusion curve is positive for all pure substances
16. The specific volume of water when heated at 0°C—
    (A) First increases and then decreases
    (B) First decreases and then increases
    (C) Increases steadily
    (D) Decreases steadily
17 Internal energy of a perfect gas depends on—
    (A) Temperature, specific heat and pressure
    (B) Temperature, specific heat and enthalpy
    (C) Temperature, specific heat and entropy
    (D) Temperature only
18. In reversible polytropic process—
    (A) True heat transfer occurs
    (B) The entropy remains constant
    (C) The enthalpy remains constant
    (D) The internal energy remains constant
19. An isentropic process is always—
    (A) Irreversible and adiabatic
    (B) Reversible and isothermal
    (C) Frictionless
    (D) Reversible and adiabatic
20. Second law of thermodynamics defines—
    (A) Heat (B) Work
    (C) Enthalpy (D) Entropy
21 For any reversible adiabatic process, the change in entropy is –
    (A) Zero (B) Minimum
    (C) Maximum (D) Infinite
22. For any reversible process, the change in entropy of the system and surrounding is—
    (A) Zero (B) Unity
    (C) Negative (D) Positive
23 Kelvin-Planck's law deals with—
    (A) Conservation of energy
    (B) Conservation of heat
    (C) Conservation of mass
    (D) Conservation of heat into work
24. The property of a working substance which increases or decreases as the heat is supplied or removed in a reversible manner is known as—
    (A) Enthalpy (B) Internal energy
    (C) Entropy (D) External energy
25. The entropy may be expressed as a function of—
    (A) Pressure and Temperature
    (B) Temperature and Volume
    (C) Heat and work
    (D) All of the above
26. The change of entropy, when heat is absorbed by the gas is—
    (A) Positive
    (B) Negative
    (C) Positive and negative
    (D) None of the above
27. Gibb's function is expressed as—
    (A) $(u + PV - T_S)$ (B) $(u + PV + Tds)$
    (C) $(u + PdV - Tds)$ (D) $(u + PV - SdT)$
28. Availability function is expressed as—
    (A) $a = (u + P_0V - T_0S)$
    (B) $a = (u + P_0dV - T_0ds)$
    (C) $a = (du + P_0dV - T_0ds)$
    (D) $a = (u + P_0V + T_0S)$
29. For each mole of oxygen, number of moles of nitrogen required for complete combustion of carbon are—
    (A) 20/21 (B) 2/21
    (C) 77/21 (D) 79/21
30. The most important solid fuel is—
    (A) Wood (B) Charcoal
    (C) Coal (D) All of the above

31 A chemical fuel is a substance which releases ..... on combustion
(A) Chemical energy
(B) Heat energy
(C) Sound energy
(D) Magnetic energy

32. The smallest particle which can take part in a chemical change is called ?
(A) Atom (B) Molecule
(C) Electron (D) Compound

33. The relative humidity during cooling and dehumidification of moist air—
(A) Increases
(B) Decreases
(C) Can increase or decrease
(D) Remains constant

34. The relative humidity, during sensible heating—
(A) Can increase or decrease
(B) Increase
(C) Decrease
(D) Remains constant

35. An air washer can work as a—
(A) Filter only
(B) Humidifier only
(C) Dehumidifier only
(D) All of the above

36. Rankine cycle efficiency of a good steam power plant may be in the range of—
(A) 15 to 20% (B) 35 to 45%
(C) 70 to 80% (D) 90 to 95%

37. In case of hyperbolic expansion of a gas, the heat supplied is ..... the work done
(A) Equal to (B) More than
(C) Less than (D) None of these

38. The reversible engines are .....
(A) Least efficient
(B) Most efficient
(C) Having same efficiency as reversible engines
(D) None of the above

39. Gases could have an infinite number of specific heats but only . specific heats are defined.
(A) One (B) Two
(C) Three (D) Four

40 Alcohol is a liquid fuel obtained from—
(A) Vegetable matter (B) Crude oil
(C) Coal (D) None of these

41 Which one of the following processes or systems does not involve heat ?
(A) Steady processes
(B) Isothermal processes
(C) Adiabatic processes
(D) Thermal processes

42 For storing a gas which one of the following types of compression will be ideal ?
(A) Constant volume
(B) Polytropic
(C) Adiabatic
(D) Isothermal

43. Which one of the following gases obeys kinetic theory perfectly ?
(A) Perfect gas (B) Pure gas
(C) Monoatomic gas (D) Diatomic gas

44 .. is not a property of the system.
(A) Pressure (B) Temperature
(C) Heat (D) Specific volume

45 Exhaust gases from an engine possess which of the following energies ?
(A) Chemical energy (B) Potential energy
(C) Solar energy (D) Kinetic energy

46. Diffusion is
(A) Mixing of unlike fluids
(B) Mixing of two portions of fluid
(C) Mixing of a gas in two containers at different pressure
(D) Mixing of two portions of a fluid at different temperature

47 First law of thermodynamics gives relationship between which of the following ?
(A) Heat and internal energy
(B) Heat and work
(C) Heat, work and properties of the system
(D) None of the above

48. The temperature in a process in which work is done by expanding a gas under adiabatic condition will—
(A) Decrease
(B) Increase
(C) First decrease then increase
(D) Remain unaltered

49. Theoretically, a petrol engine operates on ..... cycle.
(A) Constant entropy
(B) Constant pressure
(C) Constant volume
(D) Constant temperature

50. . cycle has the maximum efficiency
(A) Brayton (B) Carnot
(C) Rankine (D) Stirling

51. Carnot cycle is a ..... cycle.
(A) Quasi-static (B) Semi-reversible
(C) Reversible (D) Irreversible

52. .. is an irreversible cycle.
(A) Stirling cycle (B) Ericsson cycle
(C) Carnot cycle (D) None of the above

53. To which of the following are Maxwell's thermodynamics relations applicable ?
(A) Thermodynamic processes
(B) Mechanical System in equilibrium
(C) Chemical System in equilibrium
(D) Reversible process

54. A frictionless heat engine can be 100 per cent efficient if its exhaust temperature is—
(A) 0°C
(B) 0°K
(C) Equal to internal temperature
(D) None of the above

55 Water contained in a beaker can be made to boil by passing steam through it—
(A) At a pressure below the atmospheric pressure
(B) At atmospheric pressure
(C) At a pressure greater than atmospheric pressure
(D) Any of the above

56. ..... is the unit of entropy
(A) J/kg (B) kJ/K
(C) J/K (D) J/kgs

57. The thermodynamics primarily deals in change of state from—
(A) Electrical energy to useful work done
(B) Wind power to useful work
(C) Heat to work
(D) None of the above

58. In engineering thermodynamics the approach towards matter is –
(A) Macroscopic
(B) Microscopic
(C) Macroscopic and microscopic
(D) None of the above

59 A system is a specific space surrounded by a boundary. A thermodynamics analysis is concerned with—
(A) Enery transfer only
(B) Mass transfer only
(C) Energy and mass transfer only
(D) None of the above

60. In a closed system—
(A) Energy transfers from surrounding to system
(B) Energy transfers from system to surrounding
(C) Energy transfers from system to surrounding and vice versa
(D) Energy as well as mass cross the [redacted]

61 The condition for as irreversible cyclic process is—
(A) $\oint = \frac{\delta Q}{T} = 0$ (B) $\oint = \frac{\delta Q}{T} < 0$
(C) $\oint \frac{\delta Q}{T} > 0$ (D) None of these

62. The condition for a reversible cyclic process is—
(A) $\oint \frac{\delta Q}{T} = 0$ (B) $\oint \frac{\delta Q}{T} < 0$
(C) $\oint \frac{\delta Q}{T} > 0$ (D) None of these

63. Internal energy of a perfect gas is a function of—
(A) Temperature only
(B) Temperature and pressure
(C) Pressure only
(D) Volume only

64. The mechanical equivalent of heat 'J' is equal to –
(A) 4·1868 kg/K.cal
(B) 41·8 kJ/K.cal
(C) 4·1868 kJ/K.cal
(D) None of the above

65. According to first law of thermodynamics –
(A) $\int dW = J\int dQ$ (B) $\int dW < J\int dQ$
(C) $\int dW > J\int dQ$ (D) None of the above

66. Centrifugal pump is an example of—
(A) Isolated system
(B) Closed system
(C) Steady flow system
(D) None of the above

67. Flow of energy is due to—
(A) Transfer of mass across the boundaries of the system
(B) Change of temperature
(C) Height above the earth surface
(D) None of the above

68. Bomb calorimeter is an example of—
(A) Open system
(B) Closed system
(C) Steady flow system
(D) Isolated system

69 Liquids have—
(A) Two distinct values of specific heat
(B) Only one value of specific heat
(C) Different values of specific heat at same temperature
(D) No specific heat

70 For any gas—
(A) $C_p = C_v$ (B) $C_p < C_v$
(C) $C_p > C_v$ (D) None of these

71. Which is correct ?
(A) $C_p - C_v = R \times J$ (B) $C_p - C_v = R/J$
(C) $C_p - C_v = J/R$ (D) $C_p - C_v = R - J$

72. The absolute temperature on centigrade scale at which volume of gas becomes zero is—
(A) $-460°C$ (B) $-273°C$
(C) $+80°C$ (D) $+100°C$

73 Molar volume is equal to—
(A) 22·41 $m^3$ at N T.P
(B) 2·241 $m^3$ at N T.P
(C) 29·27 $m^3$ at N T.P.
(D) 1·03 $m^3$ at N T.P.

74. General energy equation for steam boiler is given by—
(A) $Q = H_2 - H_1$
(B) $Q = H_1 + H_2$
(C) $Q = H_2 - H_1 +$ Work done
(D) $Q = H_2 - H_1 +$ Kinetic energy

75. According to law of conservation of energy—
(A) $dQ = dW$ (B) $dQ = dU$
(C) $dQ = dW - dU$ (D) $dQ = dW + dU$

76. Enthalpy (H) is equal to—
(A) $U + \frac{PV}{J}$ (B) $U - \frac{PV}{J}$
(C) $U + \frac{R}{JPV} = 1$ (D) $V + JPV$

77 In a throttling process the—
(A) Volume remains constant
(B) Pressure remains constant
(C) Temperature remains constant
(D) All the three remain constant

78 Work done will be zero in case of—
(A) Isothermal process
(B) Adiabatic process
(C) Free expansion
(D) None of the above

79. Constant volume process is also known as—
(A) Isotropic process
(B) Hyperbolic process
(C) Isometric process
(D) Polytropic process

80. When a gas is heated according to the $P \times V =$ Constant the expansion is called—
(A) Hyperbolic (B) Polytropic
(C) Free expansion (D) None of these

81 If $H_1$ and $H_2$ are initial and final enthalpy of a given fluid, then in throttling process—
(A) $H_1 > H_2$ (B) $H_1 < H_2$
(C) $H_1 = H_2$ (D) None of these

82. A refrigeration system works on—
(A) Second law of thermodynamics
(B) First law of thermodynamics
(C) Zeroth law of thermodynamics
(D) None of the above

83. Which of the following cycle has the highest efficiency ?
(A) Otto cycle (B) Carnot cycle
(C) Stirling cycle (D) Joule cycle

84. Gas turbine works on –
(A) Constant volume cycle
(B) Otto cycle
(C) Ericsson cycle
(D) Joule cycle

85. Thermal power plant works on—
(A) Rankine cycle
(B) Otto cycle
(C) Joule cycle
(D) Constant pressure cycle

86. Petrol engine works on—
(A) Constant pressure cycle
(B) Constant volume cycle
(C) Joule cycle
(D) Rankin cycle

87. Constant volume cycle is also known as—
(A) Otto cycle (B) Rankin cycle
(C) Joule cycle (D) Atkinson cycle

88. Joule cycle is also known as—
(A) Ericsson cycle (B) Otto cycle
(C) Carnot cycle (D) Brayton cycle

89 Reverse Joule cycle is also known as—
(A) Ericsson cycle
(B) Atkinson cycle
(C) Bell Coleman cycle
(D) Otto cycle

90 Which one is natural solid fuel ?
(A) Charcoal (B) Coke
(C) Peat (D) None of these

91. Coke is prepared from—
(A) Peat (B) Wood
(C) Bituminous (D) Producer gas

92. Which fuel has the maximum percentage of carbon ?
(A) Wood (B) Coke
(C) Lignite (D) Coal

93. The solid fuel having the highest calorific value is—
(A) Wood (B) Lignite
(C) Coke (D) Anthracite

94. For complete combustion of 1 Kg of carbon is required—
(A) 8 kg of oxygen
(B) 8/3 kg of oxygen
(C) 3/8 kg of oxygen
(D) None of the above

95 100 kg of air contains—
(A) 21 kg of oxygen (B) 35 kg of oxygen
(C) 23 kg of oxygen (D) 73 kg of oxygen

96. Bomb calorimeter is used for determining—
(A) Specific gravity of fuel
(B) Calorific value of fuel
(C) Specific heat of fuel
(D) Viscosity of fuel

97. The volumetric analysis of dry products of combustion is done by—
(A) Bomb calorimeter
(B) Viscosity meter
(C) Orsat apparatus
(D) Calorimeter

98. The kerosene is generally used as a fuel—
(A) For road fraction
(B) For lighting and cooking
(C) In thermal power plants
(D) For industrial furnaces

99. The percentage of carbon in crude oil varies between—
(A) 83% to 87% (B) 50% to 60%
(C) 90% to 94% (D) 40% to 45%

100 The ratio of root mean square velocity to average velocity of gas molecules at a particular temperature is—
(A) 0·086 (B) 1·086
(C) 3·086 (D) 4·086

101 The velocity of molecules—
(A) Increases with the increase of temperature
(B) Increases with the decrease of temperature
(C) Decreases with the increase of temperature
(D) Remains constant at all temperatures

102 The work done in free expansion process is—
(A) Zero (B) Minimum
(C) Maximum (D) Positive

103. In a steady flow process—
(A) The mass flow rate is constant

(B) The work transfer rate is constant
(C) The heat transfer rate is constant
(D) All of the above

104. When a gas is heated at constant volume—
(A) Its pressure will increase
(B) Its temperature will increase
(C) Both temperature and pressure will increase
(D) Neither temperature nor pressure will increase

105. The hyperbolic process is governed by—
(A) Boyle's law (B) Charle's law
(C) Gay-Lussac law (D) Joule's law

106 The general law of expansion or compression is $PV^n = C$. The process is said to be hyperbolic, if $n$ is equal to—
(A) $\infty$ (B) 0
(C) 1 (D) $\gamma$

107. The value of gas constant (R) is—
(A) 2·87 J/kgK (B) 287 J/kgK
(C) 28·7 J/kgK (D) 0·287 J/kgK

108. The value of universal gas constant ($R_u$) is—
(A) 8314 J/kgK (B) 8·314 J/kgK
(C) 83·14 J/kgK (D) 831·4 J/kgK

109 The value of $C_p/C_v$ for air is—
(A) 1·2 (B) 1·3
(C) 1·4 (D) 2·3

110 Atmospheric pressure is equal to—
(A) 1·013 bar (B) 760 mm of Hg
(C) 101·3 kN/m$^2$ (D) All of these

111. When neither mass or energy is allowed to cross the boundary of a system, it is then called—
(A) Open system (B) Closed system
(C) Isolated system (D) None of these

112. Kelvin-Planck's law deals with—
(A) Conservation of heat
(B) Conservation of mass
(C) Conservation of heat into work
(D) Conservation of work

113. Which of the following is not a thermodynamic property ?
(A) Pressure
(B) Temperature
(C) Heat
(D) Specific volume

114. The efficiency of Diesel cycle approaches to otto cycle efficiency when—
(A) Cut-off is increased
(B) Cut-off is decreased
(C) Cut-off is zero
(D) Cut-off is constant

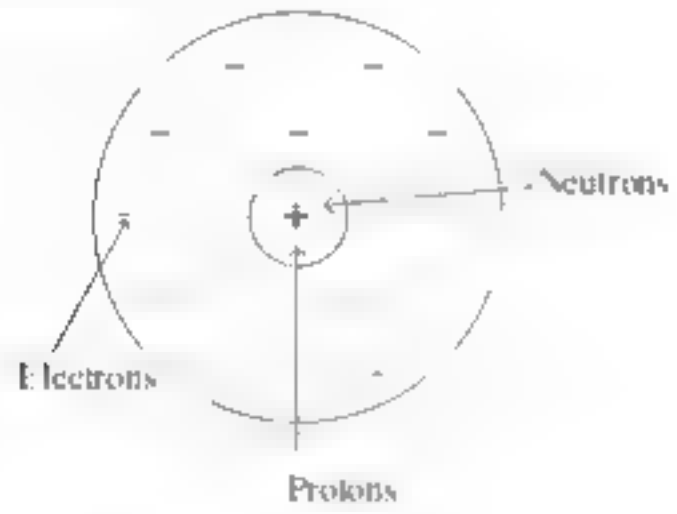
## Answers

| | | | | |
|---|---|---|---|---|
| 1. (B) | 2. (C) | 3. (A) | 4. (C) | 5. (C) |
| 6 (C) | 7. (D) | 8. (B) | 9. (B) | 10 (B) |
| 11. (A) | 12. (A) | 13. (A) | 14. (B) | 15. (A) |
| 16 (B) | 17. (D) | 18. (A) | 19. (D) | 20. (D) |
| 21. (A) | 22. (A) | 23. (D) | 24. (C) | 25. (A) |
| 26. (A) | 27. (A) | 28 (A) | 29. (D) | 30. (C) |
| 31 (B) | 32. (A) | 33. (C) | 34. (B) | 35. (D) |
| 36 (B) | 37 (A) | 38 (B) | 39. (B) | 40. (A) |
| 41 (C) | 42 (D) | 43 (A) | 44. (C) | 45. (D) |
| 46. (A) | 47 (C) | 48 (A) | 49. (C) | 50. (B) |
| 51 (C) | 52 (D) | 53 (C) | 54 (B) | 55. (C) |
| 56 (B) | 57 (C) | 58 (A) | 59 (C) | 60. (C) |
| 61 (B) | 62 (A) | 63 (A) | 64 (C) | 65. (A) |
| 66 (C) | 67 (A) | 68 (B) | 69 (B) | 70 (C) |
| 71 (B) | 72 (B) | 73 (A) | 74. (A) | 75. (D) |
| 76. (A) | 77 (C) | 78 (C) | 79 (C) | 80. (A) |
| 81 (C) | 82 (A) | 83 (B) | 84 (C) | 85. (A) |
| 86 (B) | 87 (A) | 88 (D) | 89. (D) | 90 (C) |
| 91 (C) | 92 (B) | 93 (D) | 94. (B) | 95. (C) |
| 96 (B) | 97 (C) | 98 (B) | 99. (A) | 100 (B) |
| 101 (A) | 102 (A) | 103. (D) | 104 (C) | 105. (A) |
| 106 (C) | 107. (B) | 108 (A) | 109 (C) | 110. (D) |
| 111. (C) | 112 (C) | 113 (C) | 114 (B) | |

# 2 NUCLEAR POWER PLANT

## Atomic Structure

Atom may be regarded as a sphere of diameter $10^{-10}$ meter but whole of the positive charge and almost the entire mass of the atom is concentrated in a small central core called nucleus having diameter of about $10^{-14}$ metre and the nucleus is surrounded by electrons. As the atom is electrically neutral, the total positive charge on the nucleus is equal to the total negative charge of the electrons in it. Electrons revolve around the nucleus in circular orbits, the necessary centripetal force is provided to them by the electrostatic force of attraction




## Proton

Proton is a positively charged particle The magnitude of charge on it is $1{\cdot}6 \times 10^{-19}$ coulomb. Further rest mass is 1836·1 times the rest mass of electron. The rest mass of proton is $1{\cdot}6725 \times 10^{-27}$ kg It has got intrinsic angular momentum (spin) equal to $\frac{I}{2}$. It is denoted by ${}_1H^1$. It means that its atomic weight is 1 and atomic number is also 1.

## Neutron

Neutron possesses no charge and its rest mass is 1838 6 times the rest mass of electron. Neutron has got intrinsic angular momentum equal to that of proton It is represented by ${}_0n^1$. It means that its atomic weight is 1 and atomic number is zero.

## Isotopes

The atoms of an element which have the same atomic number but different mass number are called isotopes Such elements cannot be separated by chemical means and different techniques have been developed for their separation and to study their relative abundance

**Example**—(i) ${}_8O^{16}$, ${}_8O^{17}$, ${}_8O^{18}$ (ii) ${}_{17}Cl^{35}$, ${}_{17}Cl^{37}$ (iii) ${}_{82}Pb^{206}$, ${}_{82}Pb^{207}$, ${}_{82}Pb^{208}$

## Isobars

The atoms of an element which have the same mass number but different atomic number are called isobars The chemical properties of isobars are different

**Example**—(i) ${}_{18}Ar^{40}$, ${}_{20}Ca^{40}$ (ii) ${}_{32}Ge^{76}$, ${}_{34}Se^{76}$ (iii) ${}_1H^3$, ${}_2He^3$

## Isotones

The nuclei having equal number of neutrons are called isotones For them, both the atomic number (Z) and the atomic mass (A) are different, but the value of A – Z is same

**Example**—(i) ${}_3Li^7$, ${}_4Be^8$ (ii) ${}_1H^3$, ${}_2He^4$ (iii) ${}_{11}Na^{23}$, ${}_{12}Mg^{24}$

## Nuclear Fission

When a big fragment such as Uranium(235) is bombarded with neutrons, this phenomenon of splitting of a heavy nucleus into two nearly equal parts Barium(141) and Krypton(92) with the release of considerable or huge energy is called nuclear fission

$${}_{92}U^{235} + {}_0n^1 \rightarrow {}_{92}U^{236} \rightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3{}_0n^1 + 200\ MeV$$

A nucleus which splits in this way is called a fissionable one. This is the principle of atom bomb. The liquid drop model of nucleus gives the clear concept of the nuclear fission process

## Nuclear fusion

Nuclear fusion is the process in which two light elements combine to form a new light element with the release of energy due to the disappearance of mass in the process of union of the nuclei. This is the principle of hydrogen bomb and it is believed that the sun's energy is due to this nuclear fusion process.

The reaction going on in hydrogen bomb is :

$_1H^2$ (Deuterium) + $_1H^2$ (Deuterium)

$\rightarrow$ $_2He^4$ (Helium) + $_0n^1$ + 3·3 MeV

$_1H^2$ (Deuterium) + $_1H^3$ (Tritium)

$\rightarrow$ $_2He^4$ (Helium) + $_0n^1$ + 17·6 MeV

## Thermal Neutrons

The neutrons which have been slowed down as a result of the collisions against the hydrogen nuclei of the moderator are called thermal neutrons. Such neutrons possess energy corresponding to room temperature $\left(\frac{3}{2}KT\right)$ Such neutrons are used to cause the fission of $_{92}U^{235}$ nuclei

## Work Function

The minimum energy of photon required to liberate an electron from the given metal surface is known as photo-electric work function

## Types of Power Plants

The principal types of power plants are as under :

1. Steam plant using coal, oil or nuclear fission
2. Internal combustion engine plants
3. Gas turbine plants
4. Hydro-electric plants

## Essential Components of a Nuclear Reactor

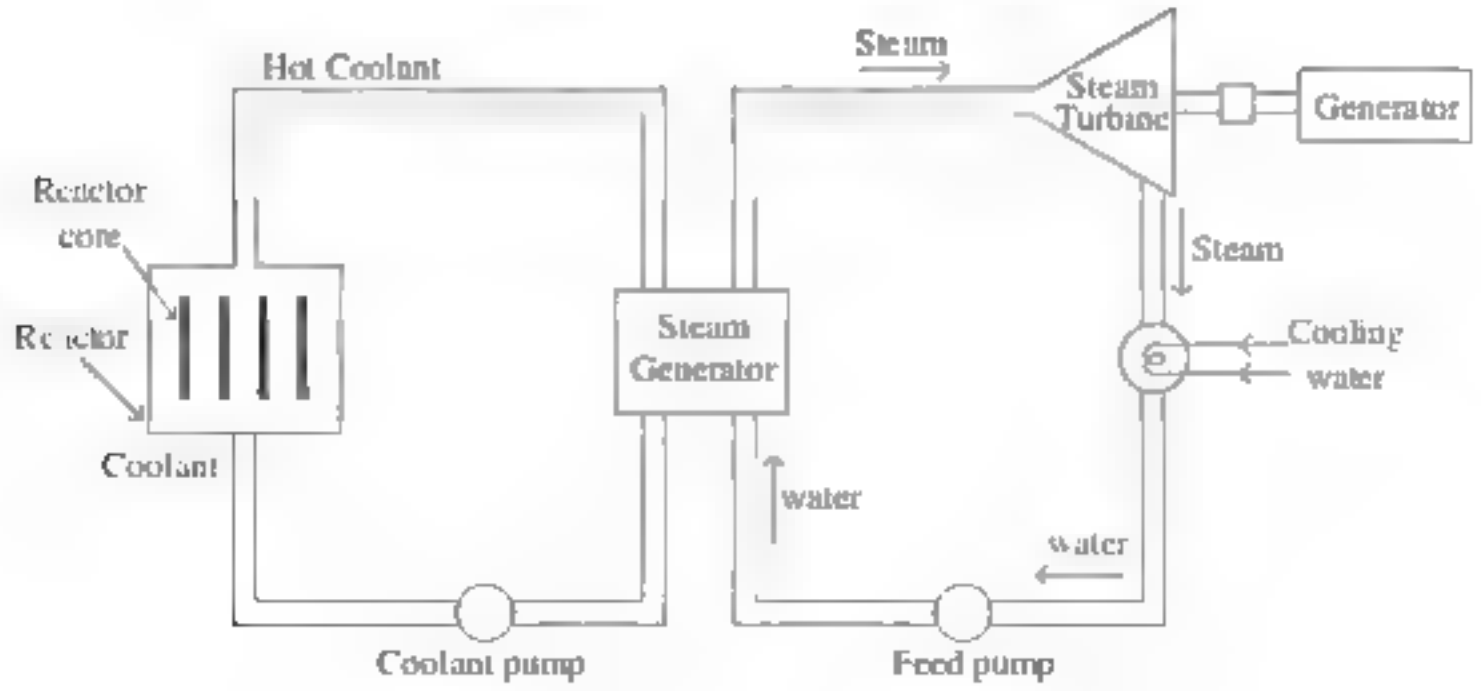
The essential components of a nuclear reactor are as follows :

1. Reactor core
2. Reflector
3. Control mechanism
4. Moderator
5. Coolants
6. Measuring instruments
7. Shielding

## Types of Nuclear Reactors

1. Pressurised water reactor (PWR)
2. Boiling water reactor (BWR)
3. CANDU (Canadian–Deuterium–Uranium) reactor
4. Gas cooled reactor
5. Liquid metal cooled reactor
6. Breeder reactor

## Main Components of a Nuclear Power Plant



The main components of a nuclear power plant are .

1. Nuclear reactor
2. Heat exchanger (Steam generator)
3. Steam turbine
4. Condenser
5. Electric generator

In a nuclear power plant the reactor performs the same function as that of the furnance of steam power plant. The heat liberated in the reactor as a result of the nuclear fission of the fuel is taken up by the coolant circulating through the reactor core. Hot coolant leaves the reactor at the top and then flows through the tubes of steam generator and passes on its heat to the feed water. The steam so produced expands in the steam turbine, producing work and thereafter is condensed in the condenser. The steam turbine in turn runs an electric generator thereby producing electric energy. Here parts are :

(1) **Moderator**—Moderator is the material used to slow down the speed of the neutrons

(2) **Reflector**—The function of reflector is to prevent escaping of neutrons and to reflect them back into the core

(3) **Shield**—The reactor core and the cooling circuit is shielded to prevent leakage of hazardous radiation from the plant

(4) **Control Rods**—The rods used to control the chain reaction in the reactor core are known as control rods.

(5) **Coolants**—Coolants are used to carry away the heat from the core for generating steam. The various coolants used are helium, water, liquid, metals, hydrogen etc.

## OBJECTIVE QUESTIONS

1. Electron was discovered by—
   (A) Faraday (B) Rutherford
   (C) Thomson (D) Kongen
2. The ratio of specific charge of an electron to that of an α-particle is—
   (A) 1 : 4 (B) 1 : 2
   (C) 4 : 1 (D) 2 : 1
3. When an electron moves in a transverse magnetic field, its path becomes—
   (A) Straight line (B) Circular
   (C) Parabola (D) Elliptical
4. The size of an electron is of the order of—
   (A) Fermi (B) Angstrom
   (C) Micron (D) Nanometer
5. Cathode rays consist of a beam of—
   (A) Proton (B) Positive ions
   (C) Electron (D) None of these
6. The radius of the nucleus is of the order of—
   (A) $10^{-15}$ m (B) $10^{-18}$ m
   (C) $10^{-14}$ m (D) $10^{-16}$ m
7. The ratio of the size of an atom to that of nucleus is equal to—
   (A) $10^{-4}$ (B) $10^{-5}$
   (C) $10^{-3}$ (D) $10^{8}$
8. The nucleus of an atom consists of—
   (A) Protons
   (B) Protons and electrons
   (C) Protons and neutrons
   (D) None of the above
9. The binding energy of hydrogen atom is—
   (A) 1 eV (B) Infinite
   (C) −13·6 eV (D) Zero
10. Nuclear fission was discovered by—
    (A) Rutherford
    (B) Curie
    (C) Becquerel
    (D) Hahn and Strassmann
11. Sun releases enormous amount of energy by the process known as—
    (A) Fusion (B) Fission
    (C) Combustion (D) Impulsion
12. Which of the following helps in knowing about the stability of nucleus ?
    (A) Binding energy
    (B) Binding energy per nucleon
    (C) Both (A) and (B)
    (D) None of these

13. The commercial sources of energy are—
    (A) Solar, wind, biomass
    (B) Fossil fuels, hydropower and nuclear energy
    (C) Wood, animal wastes and agriculture wastes
    (D) None of the above
14. Non-commercial sources of energy are—
    (A) Wood, animal wastes and agricultural wastes
    (B) Solar, wind, biomass
    (C) Fossil fuels, hydropower and nuclear power
    (D) None of the above
15 The primary sources of energy are—
    (A) Coal, oil and uranium
    (B) Hydrogen, oxygen and water
    (C) Wind, biomass and geothermal
    (D) None of the above
16 The secondary sources of energy are—
    (A) Solar, wind and water
    (B) Coal, oil and uranium
    (C) Both (A) and (B)
    (D) None of the above
17. India's first Nuclear Power Plant was built in the year—
    (A) 1947 (B) 1949
    (C) 1962 (D) 1966
18. The percentage of $O_2$ by weight in atmospheric air is—
    (A) 18% (B) 23%
    (C) 77% (D) 79%
19. The percentage of $O_2$ by volume in atmospheric air is—
    (A) 21% (B) 23%
    (C) 77% (D) 79%
20. The proper indication of incomplete combustion is—
    (A) High CO content in fuel gases at exit
    (B) High $CO_2$ content in fuel gases at exit
    (C) High temperature of fuel gases
    (D) The smoking exhaust from chimney
21 The main source of production of biogas is—
    (A) Human waste
    (B) Wet cow dung
    (C) Wet livestock waste
    (D) All the above
22 India's first nuclear power plant was installed at—
    (A) Tarapur (B) Kota
    (C) Kalpakkam (D) None of the above
23. In fuel cell, the ..... energy is converted into electrical energy
    (A) Mechanical (B) Chemical
    (C) Heat (D) Sound
24 Solar thermal power generation can be achieved by—
    (A) Using focussing collector or heliostales
    (B) Using flat plate collectors
    (C) Using a solar pond
    (D) Anyone of the above system
25. The energy radiated by sun on a bright sunny day is approximately—
    (A) 700 $W/m^2$ (B) 800 $W/m^2$
    (C) 1 $KW/m^2$ (D) 2 $KW/m^2$
26. Thorium Breeder Reactors are most suitable for India because—
    (A) These develop more power
    (B) Its technology is simple
    (C) Abundance of thorium deposits are available in India
    (D) None of the above
27. Rankine cycle is a—
    (A) Reversible cycle
    (B) Irreversible cycle
    (C) Constant volume cycle
    (D) None of the above
28. A steam power station requires space—
    (A) Equal to diesel power station
    (B) More than diesel power station
    (C) Both (A) and (B)
    (D) None of the above
29. Economiser is used to heat—
    (A) Air (B) Feed water
    (C) Fuel gases (D) All of the above

30. The modern steam turbines are –
(A) Impulse turbines
(B) Reaction turbines
(C) Impulse-reaction turbines
(D) None of the above

31. The draught, which a chimney produces is called –
(A) Induced draught
(B) Natural draught
(C) Forced draught
(D) Balanced draught

32. The draught produced by steel chimney as compared to that produced by brick chimney for the same height is—
(A) Less
(B) More
(C) Same
(D) May be more or less

33. Thermal efficiency of a gas turbine plant as compared to diesel engine plant is—
(A) Higher (B) Lower
(C) Same (D) None of the above

34 Mechanical efficiency of a gas turbine as compared to internal combustion reciprocating engine is—
(A) Higher (B) Lower
(C) Same (D) None of the above

35. For a gas turbine the pressure ratio may be in the range—
(A) 2 to 3 (B) 3 to 5
(C) 16 to 18 (D) 18 to 22

36 A closed cycle gas turbine works on—
(A) Carnot cycle (B) Rankine cycle
(C) Joule cycle (D) Atkinson cycle

37. Thermal efficiency of closed cycle gas turbine plant increases by—
(A) Reheating (B) Intercooling
(C) Regenerator (D) All of the above

38. The average thermal efficiency of a modern nuclear power plant is about—
(A) 30% (B) 40%
(C) 60% (D) 80%

39 Reflector of a nuclear reactor are made up of –
(A) Boron (B) Cast iron
(C) Beryllium (D) Steel

40. The function of a moderator in a nuclear reactor is –
(A) To slow down the fast moving electrons
(B) To speed up the slow moving electrons
(C) To start the chain reaction
(D) None of the above

When a nuclear reactor is operating at constant power the multiplication factor is—
(A) Less than unity (B) Greater than unity
(C) Equal to unity (D) None of the above

42 The conversion ratio of a breeder reactor is—
(A) Equal to unity (B) More than unity
(C) Less than unity (D) None of the above

43 In the nuclear fission reactions ..... isotope of uranium is used.
(A) $U^{235}$ (B) $U^{234}$
(C) $U^{238}$ (D) None of the above

44. Tarapur nuclear power plant has—
(A) Pressurised water reactors
(B) Boiling water reactors
(C) CANDU type reactors
(D) None of the above

45 Critical mass of fuel is the amount required to make the multiplication factor ..... unity.
(A) Equal to (B) Less than
(C) More than (D) None of the above

46. The nuclear energy is measured in—
(A) MeV (B) MW
(C) Curie (D) None of the above

47 Fission chain reaction is possible when—
(A) Fission produces the same number of neutrons which are absorbed
(B) Fission produces more neutrons than are absorbed
(C) Fission produces less neutrons than are absorbed
(D) None of the above

48 In nuclear chain fission reaction, each neutron which causes fission produces—
(A) No new neutron
(B) One new neutron
(C) More than one new neutron
(D) None of the above

49. ..... is the most commonly used moderator
(A) Graphite (B) Sodium
(C) Deuterium (D) Any of the above

50. Which of the following are fertile materials ?
(A) $U^{238}$ and $Th^{239}$
(B) $U^{238}$ and $Th^{232}$
(C) $U^{233}$ and $Pu^{239}$
(D) $U^{238}$ and $Pu^{239}$

51. In a nuclear reactor the function of a reflector is to—
(A) Reduce the speed of the neutrons
(B) Stop the chain reaction
(C) Reflect the escaping neutrons back into the core
(D) All of the above

52. In a Gas Cooled Reactor (GCR) ..... are used as moderator and coolant respectively.
(A) Heavy water and $CO_2$
(B) Graphite and air
(C) Graphite and $CO_2$
(D) None of the above

53 A CANDU reactor uses—
(A) Only fertile material
(B) Highly enriched uranium (85% $U^{235}$)
(C) Natural uranium as fuel and heavy water as moderator and coolant
(D) None of the above

54 Fission of $U^{235}$ releases ..... energy
(A) 200 MeV (B) 238 MeV
(C) 431 MeV (D) None of the above

55. Fast breeder reactors are best suited for India because—
(A) Of large thorium deposits
(B) Of large uranium deposits
(C) Of large plutonium deposits
(D) None of the above

56. Generally, how many number of Jets have in Pelton wheel ?
(A) One
(B) Two
(C) Four
(D) Six

57 The function of a solar collector is to convert -
(A) Solar energy into electricity
(B) Solar energy into radiation
(C) Solar energy into thermal energy
(D) None of the above

58 Most of the solar radiation received on earth surface lies within the range of—
(A) 0·2 to 0·4 microns
(B) 0·38 to 0·78 microns
(C) 0 to 0·38 microns
(D) None of the above

59 Flat plate collector absorbs—
(A) Direct radiation only
(B) Diffuse radiation only
(C) Direct and diffuse both
(D) None of the above

60. Temperature attained by a flat-plate collector is of the—
(A) Order of above 90°C
(B) Range of 100°C to 150°C
(C) Above 15°C
(D) None of the above

61 A Pyranometer is used for measurement of—
(A) Direct radiation only
(B) Diffuse radiation only
(C) Direct as well as diffuse radiation
(D) None of the above

62. Sun tracking is needed in the case of .... collector
(A) Flate plate
(B) Cylindrical parabolic and paraboloid
(C) Both (A) and (B)
(D) None of the above

63. The nucleus of an atom consists of—
(A) Protons and electrons
(B) Protons and neutrons
(C) Neutrons and electrons
(D) None of the above

64. Each proton carries a single unit—
(A) Positive charge (B) Negative charge
(C) Neutral charge (D) Unpredictable

65. Each neutron carries a single unit—
(A) Negative charge (B) Positive charge
(C) Neutral charge (D) None of the above

66. Each electron carries a single unit –
(A) Negative charge (B) Positive charge
(C) Neutral charge (D) None of the above

67. If A = mass number, Z = atomic number then number of neutrons in the nucleus are equal to—
(A) A + Z (B) A – Z
(C) A × Z (D) A / Z

68. The method of identifying the element is—
(A) ${}_{Z}X^{A}$ (B) $X^{AZ}$
(C) ${}_{A}X^{Z}$ (D) $X^{A/Z}$

69. The lithium element is represented as ${}_{3}Li^{7}$ The sum of protons and electrons is equal to—
(A) 10 (B) 3
(C) 7 (D) 4

70. If carbon is represented as ${}_{6}C^{12}$, then the number of electrons are equal to—
(A) 6 (B) 12
(C) 18 (D) 2

71. If Beryllium is represented as ${}_{5}Be^{9}$ then the number of neutrons are equal to—
(A) 9 (B) 5
(C) 14 (D) 4

72. The compound nucleus has—
(A) Kinetic energy
(B) Binding energy of bombarding particles
(C) Both K.E. and B.E. of bombarding particles
(D) None of the above

73. Isotopes of the element has—
(A) Same number of neutrons
(B) Different number of neutrons
(C) Same atomic weight
(D) None of the above

74. The radiation emitted are of—
(A) Two type (B) Three type
(C) Four type (D) None of the above

75. Which one of the following is most harmful for the human body ?
(A) Alpha particles
(B) Beta particles
(C) Gamma particles
(D) None of the above

76. Pick up the correct equation in which alpha particles are emitted –
(A) ${}_{92}U^{238} \rightarrow {}_{2}He^{4} + {}_{90}Th^{234}$
(B) ${}_{92}U^{238} \rightarrow {}_{2}He^{4} + {}_{92}Th^{238}$
(C) ${}_{92}U^{238} \rightarrow {}_{4}He^{2} + {}_{90}Th^{234}$
(D) ${}_{92}U^{238} \rightarrow {}_{2}He^{4} + {}_{94}Th^{142}$

77 The division of heavy nucleus into smaller ones is called—
(A) Fusion (B) Fission
(C) Vaporization (D) None of the above

78. Combining of light nuclei to form a single heavy nucleus is called—
(A) Fusion (B) Fission
(C) Solidification (D) Atomization

79. Natural uranium is principally a mixture of—
(A) Two isotopes (B) Three isotopes
(C) Four isotopes (D) None of the above

80. The uranium isotope of atomic weight 233 ($U^{233}$) can be produced from—
(A) $U^{235}$ (B) $Pu^{239}$
(C) $Th^{232}$ (D) None of the above

81 Which one of the following is fertile material?
(A) $U^{-235}$ (B) $U^{-239}$
(C) $U^{-233}$ (D) $U^{-238}$

82. The readily fissionable material is—
(A) Uranium-234 (B) Uranium-235
(C) Uranium-238 (D) All the above

83. The material used for reactor vessel is—
(A) Cast iron (B) Stainless steel
(C) Mild steel (D) Copper

84. The coolant used in a nuclear power plant is—
(A) Heavy water (B) Freon
(C) Carbon dioxide (D) Sulphur dioxide

85. In sodium graphite reactor the coolant used is—
(A) Water (B) Graphite
(C) Heavy water (D) Liquid sodium

86. The term PWR stands for—
(A) Power Water Reactor
(B) Pressurized Water Reactor
(C) Power Welding Rod
(D) Power Work Reaction

87. The gas which is used as a coolant in a nuclear power plant is—
(A) Freon (B) Ammonia
(C) Helium (D) Chlorine

88. Select the moderator used in a nuclear power plant—
(A) Uranium (B) Plutonium
(C) Hydrogen (D) Oxygen

89. In a sodium graphite reactor, the moderator used is—
(A) Heavy water (B) Light water
(C) Graphite (D) None of the above

90. Which one of the followings have a better heat transfer property ?
(A) Light water (B) Heavy water
(C) Sodium (D) Dowtherm

91. The material used for shielding a core is—
(A) Concrete
(B) Thick galvanized sheets
(C) Copper sheets
(D) Aluminium sheets

92. Concrete shield for acceptable level of radiation should be minimum—
(A) 5 metre thick (B) 2 metre thick
(C) 1 metre thick (D) 1/2 metre thick

93 The scarm control rods are used to—
(A) Control the chain reaction in the reactor
(B) Prevent radiation from the reactor
(C) Both
(D) None of the above

94. The moderator used in fast breeding reactor is—
(A) Graphite (B) Liquid sodium
(C) Heavy water (D) None of the above

95. The fuel used in a pressurized water reactor is—
(A) Enriched uranium
(B) Radium
(C) Thorium
(D) Lead

96. The pressurized water uses light water reactor as –
(A) Coolant
(B) Moderator
(C) Both (A) and (B)
(D) None of the above

97 In a homogeneous reactor the fuel used is –
(A) Uranium
(B) Lead
(C) Thorium
(D) Uranyl sulphate in heavy water

98 Which of the element is natural radioactive ?
(A) Radium (B) Thorium
(C) Uranium (D) All of the above

99 In a heterogeneous reactor metallic uranium rods are used with—
(A) Aluminium (B) Zirconium
(C) Stainless steel (D) All of the above

100. In boiling water reactor steam is generated—
(A) In the reactor vessel
(B) In the boiler
(C) In the heat exchanger
(D) None of the above

101. The fuel mostly used in boilers is—
(A) Brown coal
(B) Peat
(C) Caking bituminous coal
(D) Non-caking bituminous coal

102 Which of the following gas has the highest calorific value ?
(A) Bio gas
(B) Hydrogen
(C) Butane
(D) Methane

103 Which of the following fuel has the highest calorific value ?
(A) Peat (B) Anthracite coal
(C) Coke (D) Bituminous coal

104 Which of the following statement is uncorrect ?
(A) The liquid fuels consist of hydrocarbons
(B) The liquid fuels have higher calorific value than solid fuels
(C) A good fuel should have low ignition point
(D) The solid fuels have higher efficiency than liquid fuels

105. Petrol is distilled at—
(A) 65°C to 220°C (B) 220°C to 345°C
(C) 345°C to 470°C (D) 410°C to 525°C

106. The fuel mostly used in blast furnace for extracting pig iron ores is –
(A) Bituminous coal (B) Soft coke
(C) Pulverised coal (D) Hard coal

107. Steam coal is a –
(A) Brown coal
(B) Non-caking bituminous coal
(C) Pulverised coal
(D) Caking bituminous coal

108. The process in which heat transferred is equal to the change of enthalpy, is known as—
(A) Constant volume process
(B) Constant pressure process
(C) Constant entropy process
(D) Constant temperature process

109. The heating of wet steam at a constant temperature till it becomes dry saturated is similar to that of heating at a—
(A) Constant pressure
(B) Constant volume
(C) Constant entropy
(D) None of these

110. One kg of carbon requires.....of oxygen and produces 7/3 kg of carbon monoxide—
(A) 7/3 (B) 8/3
(C) 4/3 (D) 11/3

111. The mass of carbon per kg of fuel gas is given by—
(A) $\frac{7}{3}CO_2 + \frac{3}{11}CO$ (B) $\frac{3}{7}CO_2 + \frac{11}{3}CO$
(C) $\frac{3}{11}CO_2 + \frac{7}{3}CO$ (D) $\frac{3}{11}CO_2 + \frac{3}{7}CO$

112. Lancashire boiler is—
(A) Internally fired boiler
(B) Stationary fire tube boiler
(C) Horizontal boiler
(D) All of the above

113. Locomotive boiler is a—
(A) Single tube, horizontal, internally fired and stationary boiler
(B) Single tube, vertical, externally fired and stationary boiler
(C) Multi-tubular, horizontal, internally fired and mobile boiler
(D) Multi-tubular, horizontal, externally fired and stationary boiler

114. Which of the following is a water tube boiler?
(A) Lancashire boiler
(B) Cochran boiler
(C) Locomotive boiler
(D) Badcock and Wilcox boiler

115. A device used to increase the temperature of saturated steam without raising its pressure, is called—
(A) Fusible plug (B) Blow off cock
(C) Superheater (D) Economiser

## Answers

| | | | | |
|---|---|---|---|---|
| 1 (C) | 2. (B) | 3. (B) | 4. (A) | 5. (C) |
| 6 (C) | 7. (A) | 8 (C) | 9. (C) | 10. (D) |
| 11 (A) | 12. (B) | 13 (B) | 14. (A) | 15. (A) |
| 16 (A) | 17. (C) | 18 (B) | 19. (A) | 20. (A) |
| 21 (D) | 22 (A) | 23. (B) | 24. (D) | 25. (C) |
| 26 (C) | 27 (A) | 28 (B) | 29. (B) | 30. (C) |
| 31 (B) | 32. (B) | 33. (B) | 34. (A) | 35. (B) |
| 36 (C) | 37 (D) | 38. (A) | 39 (C) | 40. (A) |
| 41 (C) | 42 (B) | 43. (A) | 44 (B) | 45. (C) |
| 46 (A) | 47 (B) | 48 (C) | 49. (A) | 50. (B) |
| 51 (C) | 52 (C) | 53 (C) | 54. (A) | 55. (A) |
| 56 (A) | 57 (C) | 58. (A) | 59 (C) | 60. (A) |
| 61 (C) | 62 (B) | 63 (B) | 64. (A) | 65 (C) |
| 66 (A) | 67 (B) | 68 (C) | 69 (C) | 70. (A) |
| 71 (D) | 72 (C) | 73 (B) | 74 (B) | 75 (C) |
| 76 (A) | 77 (B) | 78. (A) | 79 (B) | 80 (C) |
| 81 (D) | 82 (B) | 83 (B) | 84. (A) | 85. (D) |
| 86 (B) | 87 (C) | 88 (C) | 89 (C) | 90 (C) |
| 91 (A) | 92 (A) | 93. (A) | 94. (D) | 95. (A) |
| 96 (C) | 97 (D) | 98. (D) | 99. (D) | 100. (A) |
| 101 (A) | 102 (B) | 103. (D) | 104. (D) | 105. (A) |
| 106 (D) | 107 (B) | 108 (B) | 109. (A) | 110. (C) |
| 111 (D) | 112 (D) | 113 (C) | 114. (D) | 115. (C) |

# 3 APPLIED MECHANICS

## Applied Mechanics

Applied mechanics deals with the application of laws of mechanics to the engineering problems.

## Rigid Body

A rigid body is one which does not change its shape and size under the effect of force acting over it.

## Newton's First Law of Motion

Every body continues in its state of rest or of uniform motion, in a straight line unless it is acted upon by some external force to change that state

## Newton's Second Law of Motion

The rate of change of momentum is directly proportional to the impressed force and takes place in the direction of the straight line in which the force acts

## Newton's Third Law of Motion

To every action there is an equal and opposite reaction

## Law of Conservation of Linear Momentum

Linear momentum = Mass x Velocity

$$p = m \times v$$

If no external force is applied on a system of mutually interacting bodies then total linear momentum of the system is conserved.

$$F = \frac{dp}{dt}$$

if $F = 0$

then $\frac{dp}{dt} = 0$

$\Rightarrow$ $p$ = constant

$p = mv$ = constant

## Force

A force is said to be applied when it changes or tends to change the state of rest or of motion of the body upon which it acts.

In MKS system the unit of force is kg wt. and in S.I. system is Newton.

1 kg wt. = 9·81 Newton.

## Laws of Force

The various laws used for the composition of forces are given as :

(1) Parallelogram law of forces

(2) Triangle law of forces

(3) Polygon law of forces

(1) **Parallelogram Law of Forces**—If two forces acting simultaneously on a particle, be represented in magnitude and direction by the two adjacent sides of a parallelogram then their resultant may be represented in magnitude and direction by the diagonal of the parallelogram which passes through their point of intersection.

(2) **Triangle Law of Forces**—If two forces acting simultaneously on a body are represented in magnitude and direction by the two sides of triangle taken in order then their resultant may be represented in magnitude and direction by the third side taken in opposite order

(3) **Polygon Law of Forces**—If a number of coplanar concurrent forces, acting simultaneously on a body are represented in magnitude and direction by the sides of a polygon taken in order, then their resultant may be represented in magnitude and direction by the closing side of a polygon taken in the opposite order

## Scalars

Those physical quantities which express only magnitude are called scalars or scalar quantities. They are combined by simple algebraic rules, *i.e.*

speed, distance, work, energy, power, mass, density, volume, area, time, electric current, potential difference, electromotive force etc

## Vectors

Those physical quantities which express magnitude and direction both are called vector quantities. They are combined by certain special rules such as triangle rule, parallelogram rule, and polygon rule, *i.e.* velocity, acceleration, displacement, force, linear momentum, torque, angular momentum, electric induction, gravitational field intensity *etc*

## Kinematical Equations

Motion with constant acceleration

(1) $v = u + at$

(2) $v^2 = u^2 + 2as$

(3) $s = ut + \frac{1}{2}at^2$

(4) $s_n = u + \frac{(2n-1)^2}{2}$

Motion with constant velocity :

(5) $v = u$

(6) $v^2 = u^2$

(7) $s = ut$

Retarded motion

(8) $v = u - at$

(9) $v^2 = u^2 - 2as$

(10) $s = ut - \frac{1}{2}at^2$

Motion starting from rest

(11) $v = at$

(12) $v^2 = 2as$

(13) $s = \frac{1}{2}at^2$

Motion with constant acceleration under gravity :

(14) $v = u + gt$

(15) $v^2 = u^2 + 2gh$

(16) $h = ut + \frac{1}{2}gt^2$

Free fall (Body dropped) :

(17) $v = gt$

(18) $v^2 = 2gh$

(19) $h = \frac{1}{2}gt^2$

Upward motion under gravity .

(20) $v = u - gt$

(21) $v^2 = u^2 - 2gh$

(22) $h = ut - \frac{1}{2}gt^2$

Downward motion on inclined plane .

(23) $v = u + g\sin\theta \cdot t$

(24) $v^2 = u^2 + 2g\sin\theta \cdot s$

(25) $s = ut + \frac{1}{2}g\sin\theta \cdot t^2$

Upward motion :

(26) $v = u - g\sin\theta \cdot t$

(27) $v^2 = u^2 - 2g\sin\theta \cdot s$

(28) $s = ut - \frac{1}{2}g\sin\theta \cdot t^2$

Motion starting from rest .

(29) $v = g\sin\theta \cdot t$

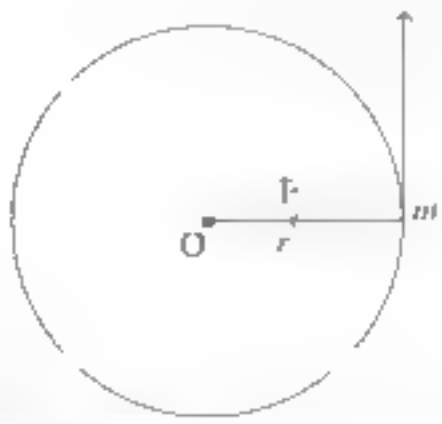
(30) $v^2 = 2g\sin\theta \cdot s$

(31) $s = \frac{1}{2}g\sin\theta \cdot t^2$

## Centripetal Force

When a particle moves on a circular path, a force always acts on it directed radially towards the centre of circle called centripetal force or central force

$$F = \frac{mv^2}{r} = m\omega^2 = m\left(\frac{2\pi}{T}\right)^2 r = m(2\pi n)^2 r$$




## Centrifugal Force

According to Newton's third law of motion, to every action there is an equal and opposite reaction Hence the agent which exerts the centripetal force, itself experiences an equal force in the direction away from the centre. This is known as centrifugal reaction and this force is known as centrifugal force

## Lami's Theorem

"If three coplanar forces acting on a point in a body keep it in equilibrium, then each force is proportional to the sine of the angle between the other two forces."

If three coplanar forces P, Q and R acting at a point O. Let the angle between P and Q be $\gamma$, between Q and R be $\alpha$ and between R and P be $\beta$ If these forces are in equilibrium then according to Lami s theorem

$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$$


## Varignon's Theorem

"The algebraic sum of the moments of two forces about any point in their plane is equal to the moment of their resultant about that point "

# Projectile

Anything projected in space which moves freely under gravity is called, projectile. The path traversed by projectile is called Trajectory

## Velocity of Projection

The velocity with which a body is projected in space is called the velocity of projection.

## Angle of Projection

The angle, which the initial velocity makes with the horizontal or at which a projectile is projected is called the angle of projection

## Range

The distance along the plane between the point of projection and point at which the projectile hits the plane at the end of its journey is called the range

## Time of Flight

This is the total time taken by the particle for which it remains in space or the time that elapses since it is projected and hits the plane again

## Maximum Height

The maximum vertical distance of projectile from the point of projection is known as its maximum height

# Friction

Friction is the property of solids due to which two solids which are in contact opposes their relative motion

According to Newton's first law of motion, a body in motion should continue to move in a straight line but this does not happen and the body comes to rest after sometime. This is done by frictional force When there is a relative motion between two solid surfaces which are in contact then a force of opposition is exerted by bodies on each other, known as frictional force

## Types of Friction

(1) Static friction

(2) Limiting friction

(3) Kinetic friction

(1) **Static friction**—The static friction is the friction offered by the surfaces subjected to external forces until there is no motion between them

(2) **Limiting friction**—Limiting force of friction may be defined as the maximum value of frictional force which exists when a body just begins to slide over the surface of the other body

(3) **Kinetic friction**—The kinetic friction is the friction experienced by a body when it is in motion It is also known as Dynamic friction.

# Collision

Collision is a such type of process in which two bodies mutually interact and exchange their momentum and kinetic energy

## Elastic Collision

Such collision in which linear momentum and K.E both are conserved is known as elastic collision

## Inelastic Collision

In this type of collisson K.E. is not conserved.

## Work

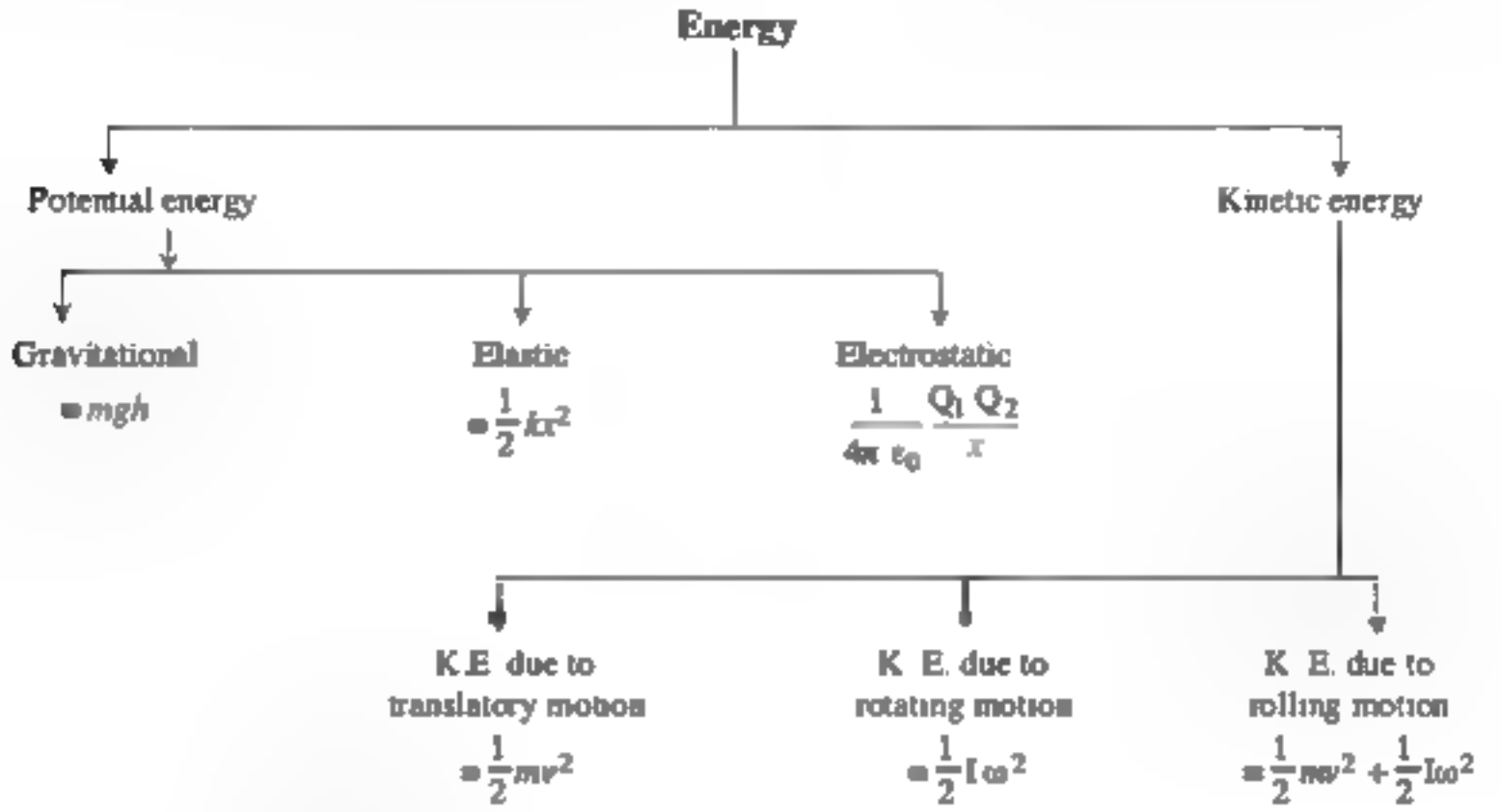
When force is applied on a body and there is displacement in the direction of force then work is said to be done.

$$W = F\cos\theta \cdot S = F\,S\cos\theta = \vec{F} \cdot \vec{S}$$

S.I. unit = Newton metre or Joule

## Energy

It is capacity of doing work. Unit is Joule.




Where, $k$ → Force constant

E → Permittivity of medium

I → Moment of inertia

## Potential Energy

The energy which a body possesses by virtue of its position or configuration is called potential energy

## Kinetic Energy

The energy which a body possesses by virtue of its motion is called kinetic energy

## Law of Conservation of Energy

The total amount of energy in the universe is constant, energy can neither be created nor destroyed although it may be converted into various forms.

## Power

It is the rate of doing work.

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

1 Unit = Joule/sec. or watt.

## Elasticity

It is the property of a substance due to which it regains its original shape on removal of external deforming force. Such substances are called elastic substances *i.e.* rubber, steel, quartz *etc*

## Plasticity

It is the property of substance due to which it does not regain its original shape on removal of external deforming forces. Such substances are known as plastic substances, *i.e.* lump of clay, lump of flour *etc*

## Brittle

Brittle substances are those which break on applying external forces, *i.e.* coal, stone, glass *etc*

## Hooke's Law

Provided the strain is small, the stress is proportional to the strain.

$$\text{Stress} \propto \text{Strain}$$

$$\text{Stress} = E \text{ Strain}$$

$$E = \frac{\text{Stress}}{\text{Strain}}$$

Where E is a material constant

## Stress

On applying external deforming force on a body the internal reactionary force produced per unit area is called stress

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

## Type of Strain

(i) Longitudinal Strain $= \frac{\text{Change in length}}{\text{Original length}}$

(ii) Volume Strain $= \frac{\text{Change in Volume}}{\text{Original Volume}}$

(iii) Lateral Strain $= \frac{\text{Change in diameter}}{\text{Original diameter}}$

(iv) Shearing Strain $= \frac{x}{h} = \phi$

## Simple Harmonic Motion (S.H.M.)

If in a oscillatory motion acceleration is directly proportional to its displacement from mean position then such motion is known as S.H.M

$$f \propto -x$$

## Periodic Motion

A motion which is repeated after fixed interval of time is known as periodic motion, *i.e.* motion of hands of watch, motion of earth around the sun.

## Oscillatory Motion

Such a motion which takes place to and fro a point and is repeated after a certain time interval is known as oscillatory motion, *i.e.* motion of simple pendulum.

## Motion of Connected Bodies

(1) Motion of two bodies ($M_1$ and $M_2$) connected by a string passing over a smooth pulley

$$\text{Acceleration (a)} = \left(\frac{M_1 - M_2}{M_1 + M_2}\right) g$$

$$\text{Tension (T)} = \frac{M_1 M_2}{M_1 + M_2}$$

and Reaction of the pulley

$$R = \frac{4 M_1 M_2}{M_1 + M_2}$$

(2) Motion of two bodies ($M_1$ and $M_2$) connected at the edge of a horizontal surface.

$$\text{Acceleration (a)} = \left(\frac{M_1 - \mu M_2}{M_1 + M_2}\right) g$$

$$\text{Tension (T)} = \frac{M_1 M_2 (1 + \mu)}{M_1 + M_2}$$

(3) Motion of two bodies ($M_1$ and $M_2$) connected by a string one end of which is hanging free and the other lying on a rough inclined plane.

Acceleration (a)

$$= \frac{2(M_1 - M_2 \sin\alpha - \mu M_2 \cos\alpha)}{M_1 + M_2}$$

$$\text{Tension (T)} = \frac{M_1 M_2 (1 + \sin\alpha + \mu \cos\alpha)}{M_1 + M_2}$$

(4) Motion of two bodies ($M_1$ and $M_2$) connected over rough inclined planes.

Acceleration (a)

$$= \frac{g\left(M_1 \sin\alpha_1 - M_2 \sin\alpha_2 - \mu_1 M_1 \cos\alpha_1 - \mu_2 M_2 \cos\alpha_2\right)}{M_1 + M_2}$$

Tension (T)

$$= \frac{M_1 M_2}{M_1 + M_2}\left(\sin\alpha_1 + \sin\alpha_2 - \mu_1 \cos\alpha_1 + \mu_2 \cos\alpha_2\right)$$

## Newton's Universal Law of Gravitation

"Every body in the universe attracts every other body with a force directly proportional to the product of their masses and inversely proportional to the square of the distance separating them."

$$F = G\frac{m_1 m_2}{d^2}$$

Where F = Force of attraction between them,

$m_1$ , $m_2$ = Masses of the bodies

$d$ = Distance between them

G = Universal gravitational constant

= $6{\cdot}07 \times 10^{-11}$ $Nm^2/kg^2$

Also, $g = G\frac{M}{R^2}$

## Parking Orbit

If a satellite revolves round the earth such that its time period of revolution is equal to the time period of revolution of earth around its own axis then satellite are called parking satellite or geostationary satellite and the orbit in which satellite moves is called parking orbit.

## Escape Velocity

The minimum velocity from the surface of celestial body with which when a body is projected never returns to its surface and crosses its gravitational field, called escape velocity from the surface of celestial body. Its value is different from surface of different celestial body. It mainly depends upon mass and radius of celestial body

$$V_e = \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$$

## Surface Tension

Surface Tension is a molecular property of liquid. Each liquid wants to minimise its free surface area. Rain drops are spherical due to this property

If a line is imagined on the surface of liquid then force acting per unit length of line perpendicular to the line and tangent to the surface is known as Surface Tension

$$T = \frac{F}{l}$$

S.I. unit = Newton/meter or $kg/sec^2$

**Factors affecting the Surface Tension—**

(1) Effect of impurities

(2) Effect of current

(3) Effect of temperature

# OBJECTIVE QUESTIONS

1. Which of the following is a scalar ?
   (A) Force
   (B) Electromotive force
   (C) Torque
   (D) None of the above
2. Which of the following is a scalar ?
   (A) Linear momentum
   (B) Electric current
   (C) Weight
   (D) None of the above
3. Which of the following is not a polar vector ?
   (A) Force
   (B) Angular velocity
   (C) Weight
   (D) None of the above
4. Which of the following is a Psuedo vector ?
   (A) Force
   (B) Gravitational field intensity
   (C) Torque
   (D) None of the above
5. Which of the following is a vector ?
   (A) Gravitational potential
   (B) Potential difference
   (C) Time
   (D) None of the above
6. Which of the following are vector quantities ?
   (A) Number of students in class
   (B) Velocity of a thrown base ball
   (C) Mass of car
   (D) None of the above
7. Pressure of an ideal gas is a—
   (A) Scalar
   (B) Vector
   (C) Neither scalar nor vector
   (D) Numerals
8. Stress is—
   (A) Vector (B) Scalar
   (C) Tensor (D) None of the above
9. Tensor of rank zero is called –
   (A) Scalar (B) Vector
   (C) Numeral (D) None of the above

10. Geometrical method of addition of two vectors is called –
    (A) Triangle method
    (B) Parallelogram method
    (C) Both
    (D) None of the above

11. If $\vec{a} \cdot \vec{a} = a^2$, then $\vec{a} \times \vec{a}$ will be—
    (A) Zero (B) $\sqrt{2}a$
    (C) $a^2 \sin\theta$ (D) None of the above

12. A jet engine works on the principle of conservation of—
    (A) Mass
    (B) Energy
    (C) Linear momentum
    (D) Angular momentum

13. A uniformly accelerating body experiences force—
    (A) In opposite direction
    (B) In the same direction of motion
    (C) Perpendicular to the direction of motion
    (D) None of the above

14 Newton's first law of motion provides the concept of—
    (A) Energy (B) Work
    (C) Inertia (D) None of the above

15. If the bucket is lowered with acceleration of 1·8 m/s$^2$ the reaction at the bottom will be—
    (A) 160 N (B) 360 N
    (C) 170 N (D) None of the above

16. Which of the following concept is independent of acceleration due to gravity ?
    (A) Surface tension
    (B) Viscosity
    (C) Archimede's principle
    (D) Both A and B

17. A hole is drilled through the earth along a diameter and a stone is dropped into it. When the stone is at the centre of earth it has only—
    (A) Mass
    (B) Weight
    (C) Acceleration
    (D) None of the above

18. The law of conservation of linear momentum can be derived from –
    (A) Newton's first law
    (B) Newton's second law
    (C) Newton's third law
    (D) None of the above

19 A soda water bottle falls under gravity. The gas bubble will—
    (A) Move upward
    (B) Move downward
    (C) Remain stationary
    (D) None of the above

20 A spring balance is pulled at its both ends with a force of 10 kg weight. The reading of the balance will be—
    (A) 10 kg wt (B) Zero
    (C) 20 kg wt (D) None of the above

21. A body moves through a distance of 8 metres under the action of a force of 10 Newton. The gain in kinetic energy is—
    (A) 80 J (B) 40 J
    (C) 120 J (D) None of the above

22. If a body moves on a circular path with uniform speed, the acceleration of the body—
    (A) Remains constant
    (B) Changes
    (C) Acts away from the centre
    (D) Is zero

23. Which of the following is a Psuedo force ?
    (A) Electromagnetic force
    (B) Cohesive force
    (C) Centripetal force
    (D) Centrifugal force

24. When milk is churned at high speed cream collects—
    (A) Near the axis
    (B) Away from the axis
    (C) At the bottom of the vessel
    (D) None of the above

25 Strain rosetters are used to—
    (A) Measure shear strain
    (B) Measure linear strain
    (C) Measure volumetric strain
    (D) Relieve strain

26. A bottle filled with soda water is grasped by the neck and swing briskly in a vertical circle The bubbles will collect near the—
(A) Neck (B) Bottom
(C) In the middle (D) None of the above

27. The angular speed of minute hand of watch is—
(A) $\frac{\pi}{1800}$ rad/sec (B) $\frac{\pi}{60}$ rad/sec
(C) $\frac{\pi}{3600}$ rad/sec (D) None of the above

28. In an amusing device Rotor, the weight of the person is supported by—
(A) Centripetal force
(B) Centrifugal force
(C) Frictional force
(D) None of the above

29. When a cyclist moves on a curved path he—
(A) Remains vertical
(B) Bends inward
(C) Bends outward
(D) Becomes horizontal

30 A piece of stone is thrown with velocity $v$ at an angle of 60° with the horizontal. The velocity at the highest point is—
(A) $\frac{v}{2}$ (B) $v$
(C) $2v$ (D) None of the above

31. The ratio of K.E. at the highest point to the initial K.E. in above problem is—
(A) $\frac{1}{2}$ (B) $\frac{1}{4}$
(C) $\frac{1}{3}$ (D) None of the above

32. A man can throw a ball upto a maximum height of $x$ metres. The maximum distance he can throw the ball on the horizontal plane is—
(A) $2x$ metres (B) $x$ metres
(C) $3x$ metres (D) None of the above

33. A man can throw a ball upto a maximum distance $x$ metres on a horizontal plane. The maximum height upto which he can throw the ball is—
(A) $\frac{x}{2}$ metres (B) $x$ metres
(C) $2x$ metres (D) None of the above

34 The maximum horizontal range of projectile is 4 km. If the projectile is thrown at an angle of 15° to the horizontal, its range will be—
(A) 2 km (B) 1 km
(C) $\frac{1}{2}$ km (D) None of the above

35 Laws of limiting friction were first of all discovered by—
(A) Leonardo da Vinci
(B) Newton
(C) Laplace
(D) None of the above

36 The static frictional force between two objects at rest w.r.t. one another is always—
(A) Less than maximum value
(B) Smaller than maximum value
(C) Equal to maximum value
(D) None of the above

37 A person runs over ground. The nature of friction between his shoes and the ground is—
(A) Static (B) Kinetic
(C) Rolling (D) None of the above

38. If the normal force is doubled, the coefficient of friction is—
(A) Not changed (B) Halved
(C) Doubled (D) Triple

39. The limiting friction between two bodies in contact is independent of—
(A) Nature of the surface in contact
(B) The area of surface in contact
(C) Normal reaction between the surface
(D) None of the above

40. In an inelastic collision the quantity that remains conserved is—
(A) Linear momentum
(B) Kinetic energy
(C) Density
(D) None of the above

41. Two bodies of the same mass and speed travelling in opposite direction collide and stick together. The velocity of compound body is—
(A) $\infty$ (B) Zero
(C) $2v$ (D) None of the above

42. In a perfectly elastic collision—
(A) Linear momentum and K.E. both are conserved
(B) Only momentum is conserved
(C) Only K.E. is conserved
(D) None of the above

43. For perfectly inelastic collision—
(A) $e = 0$ (B) $e = 1$
(C) $e < 1$ (D) None of the above

44. For inelastic collision—
(A) $e = 0$ (B) $e < 1$
(C) $e = 1$ (D) None of the above

45. For super elastic collision—
(A) $e > 1$ (B) $e = 1$
(C) $e < 1$ (D) None of the above

46. When the physical and chemical nature of the bodies is changed by the collision, the event is known as—
(A) Reaction (B) Diffraction
(C) Polarization (D) None of the above

47. When two bodies come together and interact strongly for a short time, the event is known as—
(A) Collision (B) Reaction
(C) Regelation (D) None of the above

48 If there is no change in momentum of a body then impulse of a force is—
(A) Zero (B) Infinite
(C) Constant (D) None of the above

49. For perfectly elastic collision—
(A) $e = 1$ (B) $e < 1$
(C) $e = 0$ (D) None of the above

50. In explosive collision—
(A) K.E. increases (B) K.E decreases
(C) K.E. constant (D) None of the above

51. Collision in two dimensions is also known as –
(A) Oblique collision
(B) Straight collision
(C) Head on collision
(D) None of the above

52. The stress required to cause actual fracture of a material is called the –
(A) Tangential stress
(B) Normal stress
(C) Ultimate strength
(D) None of the above

53 The shear modulus has a significance—
(A) For solid material
(B) For liquids only
(C) For gases only
(D) None of the above

54. Compressibility of air is—
(A) Greater than that of water
(B) Less than water
(C) Equal to water
(D) None of the above

55 Which one of the following is more elastic ?
(A) Rubber (B) Steel
(C) Aluminium (D) Glass

56. The P.E. per unit volume of stretched wire is—
(A) $\frac{1}{2}$ Stress × Strain (B) $\frac{\text{Stress}}{\text{Strain}}$
(C) Stress ∝ Strain (D) None of the above

57. The change in the shape of a regular body is due to—
(A) Longitudinal strain
(B) Shearing strain
(C) Volume strain
(D) None of the above

58. The ratio of the adiabatic elasticity to the isothermal elasticity is—
(A) $C_p/C_v$ (B) $C_v - C_p$
(C) $C_p - C_v$ (D) None of the above

59. Which one of the following has the property of ductility—
(A) Gold (B) Glass
(C) Air (D) Water

60. Which one of the following has the property of malleability ?
(A) Copper (B) Glass
(C) Oxygen (D) NaCl

61 Which of the following is brittle ?
(A) NaCl (B) Rubber
(C) Copper (D) Steel

62. A perfectly rigid body has value of Young's modulus—
(A) Zero (B) 1
(C) Infinite (D) None of the above

63. Modulus of rigidity of glass is—
(A) Zero (B) Infinite
(C) 1 (D) None of the above

64. Poisson's ratio of real bodies is always—
(A) Zero (B) Negative
(C) Positive (D) None of the above

65 In a pure bending the nature of strain produced is—
(A) Volume (B) Tensile
(C) Shear (D) None of the above

66. In S.H.M. the amplitude of a vibrating particle is determined by—
(A) Frequency (B) Velocity
(C) Energy (D) Wavelength

67. In S.H.M. acceleration in particle doing S.H.M. is given by $f = -\omega^2 y$. Here $\omega$ is known as—
(A) Angular velocity
(B) Pulsatance
(C) Angular speed
(D) None of the above

68 At $\frac{3T}{4}$ velocity of particle doing S.H.M (T being period of motion) is—
(A) Minimum (B) Maximum
(C) Infinite (D) None of the above

69. In S.H.M. if maximum velocity and maximum acceleration of a particle is equal, the period of oscillation is—
(A) 3·14 sec. (B) 6·28 sec
(C) $\frac{\pi}{2}$ sec (D) None of the above

70. At $\frac{T}{4}$ the acceleration of particle in SHM (T being period) is—
(A) $-\omega^2 a$ (B) $\omega^2 \frac{a}{2}$
(C) 0 (D) None of the above

71. In S.H.M —
(A) Phase and epoch both vary
(B) Phase is constant and epoch remains constant
(C) Epoch varies and phase remains constant
(D) None of the above

72 The phase difference between force and velocity in S.H.M is—
(A) 0 (B) $\frac{\pi}{2}$
(C) $\pi$ (D) None of the above

73. The phase difference between force and displacement is—
(A) 0 (B) $\frac{\pi}{2}$
(C) $\pi$ (D) None of the above

74 Energy in S.H.M. is directly proportional to—
(A) Square of amplitude
(B) Amplitude
(C) Cube of amplitude
(D) None of the above

75 P.E. curve in S.H.M is—
(A) Straight line (B) Parabola
(C) Ellipse (D) Circle

76. Energy of an oscillation is proportional to —
(A) Mass (B) (Frequency)$^2$
(C) (Amplitude)$^2$ (D) All of the above

77. The value of T (time period) will increase if—
(A) The inertia factor increases
(B) The elasticity factor decreases
(C) Both (A) and (B)
(D) None of the above

78. The motion in which time period (T) is independent of amplitude is called—
(A) Isochronous (B) Rotatory
(C) Relative (D) None of the above

79. A man jumps 2 metre on the surface of earth. How high he will jump on a planet whose radius is 64 km and mean density same as that of the earth ?
(A) 200 metre (B) 400 metre
(C) 1 metre (D) None of the above

80. A satellite is moving in a circular orbit around the earth It moves with –
(A) Constant speed
(B) Constant acceleration
(C) No force acting on it
(D) None of the above

81. The period of a satellite in a circular orbit around a planet is independent of—
(A) The mass of the planet
(B) The radius of the planet
(C) The mass of the satellite
(D) All these parameters

82. Weightlessness in space is due to—
(A) Inertia
(B) Zero gravity
(C) Zero acceleration
(D) Centre of gravity

83 The Torque exerted by sun's gravitational force on a planet moving around it is—
(A) Zero (B) Infinite
(C) 2 R (D) None of the above

84. The height at which g will be $\frac{1}{4}$th of its value at the earth surface is—
(A) $h = R$ (B) $h = \frac{R}{2}$
(C) $h = 2R$ (D) None of the above

A closed bottle filled with water at 0°C is taken to the suface of moon If the bottle is opened, the water will—
(A) Cool down (B) Boil
(C) No change (D) None of the above

86. $T_1$ is the time period of geostationary satellite and $T_2$ is the time period of rotation of the earth around its own axis. Then—
(A) $T_1 > T_2$ (B) $T_1 = T_2$
(C) $T_1 < T_2$ (D) $T_1 = 2T_2$

87. A body of mass $m$ is taken from the surface of the earth (radius R) to the height equal to R The change in P.E.—
(A) $\frac{mgR}{2}$ (B) $mgR$
(C) $\frac{1}{4}mgR$ (D) None of the above

88. The time period of a satellite in a circular orbit of radius R is T. The time period of an other satellite moving in a orbit of radius 4R is—
(A) 4T (B) 8T
(C) 2T (D) None of the above

89 The tail of a comet is away from the sun due to
(A) Radiation pressure of the sun
(B) Perihelion of the sun
(C) Nuclear fusion
(D) None of the above

90. The force responsible for surface tension is—
(A) Gravitational force
(B) Nuclear force
(C) Vander Waal force
(D) None of the above

91 Water falls in capillary tube instead of rising in capillary tube of which of the following material ?
(A) Glass (B) Copper
(C) Silver (D) Paraffin wax

92. The angle of contact for glass / mercury is—
(A) 90°
(B) Less than 90°
(C) Greater than 90°
(D) Zero

93. A liquid which does not wet solid surface has angle of contact—
(A) Obtuse angle
(B) Acute angle
(C) Straight angle
(D) None of the above

94. A liquid which wets a solid surface has angle of contact—
(A) Acute angle (B) Obtuse angle
(C) Straight angle (D) None of the above

95. Addition of detergent to liquid—
(A) Lowers the S.T. (B) Increase the S.T
(C) No effect (D) None of the above

96 Cohesion is maximum in –
(A) Solids (B) Liquids
(C) Gases (D) Same in all states

97. If water is electrified its surface tension –
(A) Increases (B) Decreases
(C) Unchanged (D) None of the above

98. If inorganic salt is mixed in water, its surface tension –
(A) Decreases (B) Increases
(C) Unchanged (D) None of the above

99. If organic salt is mixed in water its S T.–
(A) Increases (B) Decreases
(C) Unchanged (D) None of the above

100. The Molecular range is of the order of–
(A) $10^{-8}$ m (B) $10^{-9}$ m
(C) $10^{-7}$ cm (D) None of the above

101. Displacement, velocity and acceleration of a particle are–
(A) All vector quantities
(B) All vector quantities except displacement
(C) All vector quantities except velocity
(D) All vector quantities except acceleration

102. When $h = k$, the time period of oscillation of compound pendulum is–
(A) Zero (B) 1 sec
(C) Maximum (D) Minimum

103 The minimum time period of oscillation of a compound pendulum is–
(A) $2\pi\sqrt{\frac{2k}{g}}$ (B) $2\pi\sqrt{\frac{h}{g}}$
(C) $2\pi\sqrt{\frac{k}{g}}$ (D) $2\pi\sqrt{\frac{k}{2g}}$

104. The number of instantaneous centres for 8-link kinematic chain is–
(A) 8 (B) 16
(C) 24 (D) 28

105. A mechanism having $n$ links with all binary pairs will have the number of instantaneous equal to–
(A) $n(n-1)$ (B) $\frac{n(n-1)}{2}$
(C) $(2n-1)$ (D) $2n$

106 A mechanism has 7 links with all binary pairs except one which is ternary pair. The number of instantaneous centres of rotation will be –
(A) 13 (B) 14
(C) 21 (D) 42

107 Magnitude of the linear velocity of any point on the kinematic link relative to the other point in the same kinematic link is–
(A) Product of angular velocity of the link and square of distance between them
(B) Zero
(C) Product of angular velocity of the link and distance between them
(D) Product of square of angular velocity of the link and the distance between them

108. In four bar mechanism the mechanical advantage is maximum when the velocity ratio is–
(A) Minimum (B) 1
(C) Maximum (D) $\frac{1}{2}$

109 The direction of linear velocity of any point on the kinematic link relative to any other point on the same kinematic link is–
(A) Parallel to the line joining the points
(B) Perpendicular to the line joining the two points
(C) Of no significance as relative velocity is zero between link relative to any other point on the same kinematic link
(D) Not predictable unless configuration is known

110. The power transmitted by belt-drive is designed on the basis of–
(A) Average angle of contact of the two pulleys
(B) Angle of contact of the larger pulley
(C) Angle of contact of the smaller pulley
(D) Angle of contact of the driver pulley whether smaller or larger

111 The angular velocity of two pulleys connected by crossed belt or open belt, are–
(A) Directly proportional to square of their diameters
(B) Inversely proportional to square of their diameters
(C) Directly proportional to their diameters
(D) Inversely proportional to their diameters

112. If the initial tension in the belt is increased –
(A) The power transmitted may increase upto a limit and then decrease
(B) The power transmitted by the belt reduces
(C) The power transmitted by the belt increases
(D) The power transmitted by the belt remains same

113. Due to strain in the belt caused by stress up to elastic limit. The ratio of the angular velocity of driving pulley to angular velocity of driven pulley—
(A) Decreases
(B) Increases
(C) Remains same
(D) Increases up to a limit and then decreases

114. The V-belt sheaves of pulleys normally have a groove angle of—
(A) 20° to 30° (B) 34° to 38°
(C) 40° to 44° (D) 55° to 60°

115. For constant velocity ratio positive drive with large centre distance between driver and driven shaft—
(A) Gear drive is used
(B) V-belt drive is used
(C) Flat belt drive is used
(D) Chain drive is used

## Answers

| | | | | |
|---|---|---|---|---|
| 1 (B) | 2. (B) | 3. (B) | 4 (C) | 5. (D) |
| 6 (B) | 7. (A) | 8 (C) | 9. (A) | 10. (A) |
| 11 (A) | 12. (C) | 13. (B) | 14. (C) | 15. (A) |
| 16. (D) | 17. (A) | 18 (C) | 19 (C) | 20. (A) |
| 21 (A) | 22. (A) | 23. (D) | 24 (A) | 25. (B) |
| 26. (A) | 27. (D) | 28 (C) | 29. (B) | 30. (A) |
| 31 (A) | 32. (A) | 33. (A) | 34 (A) | 35. (A) |
| 36. (A) | 37. (A) | 38. (A) | 39 (B) | 40. (A) |
| 41 (B) | 42. (A) | 43. (A) | 44 (B) | 45 (A) |
| 46. (A) | 47. (A) | 48. (A) | 49 (A) | 50. (A) |
| 51. (A) | 52. (A) | 53 (A) | 54. (A) | 55. (B) |
| 56. (A) | 57. (B) | 58 (A) | 59. (A) | 60. (A) |
| 61 (A) | 62. (C) | 63. (A) | 64. (B) | 65. (B) |
| 66 (C) | 67. (B) | 68. (A) | 69. (B) | 70. (C) |
| 71 (D) | 72. (B) | 73. (C) | 74. (A) | 75. (B) |
| 76. (D) | 77. (A) | 78. (A) | 79. (A) | 80. (A) |
| 81 (C) | 82. (C) | 83. (A) | 84. (A) | 85. (B) |
| 86 (B) | 87. (A) | 88. (B) | 89. (A) | 90. (C) |
| 91 (D) | 92 (C) | 93. (A) | 94. (A) | 95. (A) |
| 96 (B) | 97. (B) | 98 (B) | 99. (B) | 100. (B) |
| 101. (A) | 102 (D) | 103. (A) | 104. (D) | 105. (B) |
| 106 (C) | 107 (C) | 108 (A) | 109. (B) | 110. (A) |
| 111 (D) | 112 (C) | 113 (B) | 114. (B) | 115. (D) |

# 4 STRENGTH OF MATERIAL

## Stress

The internal resistance of the material against deformation is known as stress

$$\therefore \quad \sigma = \frac{P}{A}$$

Where, $\sigma$ = Stress
$P$ = Load
$A$ = Area over which stress develops

## Strain

The strain (e) is the deformation produced by stress. Various types of strain are :

(1) **Tensile Strain**—A piece of material with uniform cross-section subjected to a uniform axial tensile stress, will increase its length from $l$ to $(l + \delta l)$ and increment of length $\delta l$ is the actual deformation of the material

$$\therefore \text{ Tensile Strain } = \frac{\delta l}{l}$$

(2) **Compressive Strain**—Under compressive forces, a similar piece of material would be reduced in length from $l$ to $l - \delta l$

$$\therefore \text{Compressive Strain } e = \frac{\delta l}{l}$$

(3) **Shear Strain**—In case of shearing load, a shear strain will be produced which is measured by the angle through which the body distorts

(4) **Volumetric Strain**—It is defined as the ratio between change in volume and original volume of the body and is denoted by $e_v$

$$e_v = \frac{\delta V}{V}$$

## Hooke's Law

Robert Hooke discovered experimentally that within elastic limit stress varies directly as strain.

$$\therefore \quad \text{Stress} \propto \text{Strain}$$

$$\text{or,} \quad \frac{\text{Stress}}{\text{Strain}} = \text{a constant}$$

This constant is termed as modulus of elasticity.

(1) **Young's Modulus**—It is the ratio between tensile stress and tensile strain or compressive stress and compressive strain. It is denoted by E. It is the same as modulus of elasticity :

$$E = \frac{\sigma}{e} \left[ = \frac{\sigma_t}{e_t} = \frac{\sigma_c}{e_c} \right]$$

(2) **Modulus of Rigidity**—It is defined as the ratio of shear stress $\tau$ (tau) to shear strain and is denoted by C, N or G. It is also called shear modulus of elasticity.

$$\frac{\tau}{e_s} = \text{C, N or G}$$

(3) **Bulk or Volume Modulus of Elasticity**—It may be defined as the ratio of normal stress (on each face of a solid cube) to volumetric strain and is denoted by the K

$$\frac{\sigma_n}{e_v} = K$$

## Poisson's Ratio

The ratio of lateral strain to linear strain is known as Poisson's ratio

$$\therefore \text{ Poisson's ratio } (\mu) = \frac{\text{Lateral strain or transverse strain}}{\text{Linear or primary strain}} = \frac{1}{m}$$

Where $m$ is a constant and its value varies between 3 and 4 for different materials

## Principal Planes and Principal Stresses

A body may be subjected to stresses in one plane or in different planes. There are always three mutually perpendicular planes along which the stresses at a certain point (in a body) can be

resolved completely into stresses normal to these planes. These planes which pass through the point in such a manner that the resultant stress across them is totally a normal stress are known as 'Principal Planes' and normal stresses across these planes are termed as 'Principal Stress'. The plane carrying the maximum normal stress is called the 'Major Principal Plane' and the stress called the 'Major Principal Stress'. The plane carrying the minimum normal stress is known as 'Minor Principal Plane' and the plane carrying the normal stress is known as 'Minor Principal Stress'.

## Mohr's Circle

A German scientist Otto Mohr devised a graphical method for finding out the normal and shear stresses on any interface of an element when it is subjected to two perpendicular stresses. This method is—

Let $P_x$ and $P_y$ are the principal stresses on two principal planes. We want to find stresses on an inclined plane which is perpendicular to the plane of paper and is inclined at an angle $\theta$ to the plane $P_x$ stress

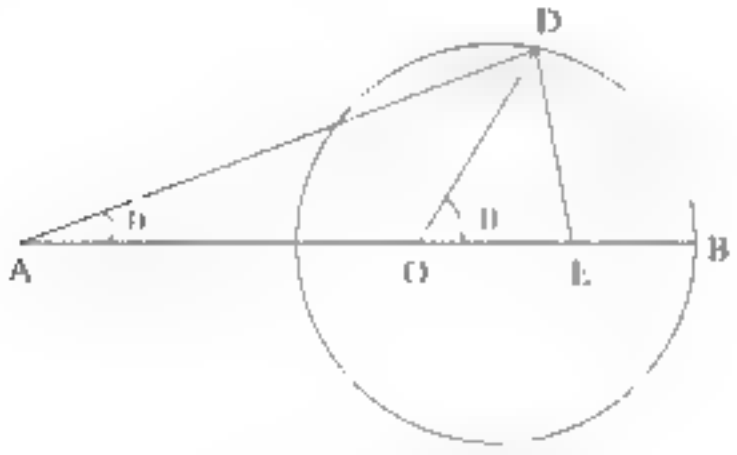



fig $P_x$ and $P_y$ both tensile

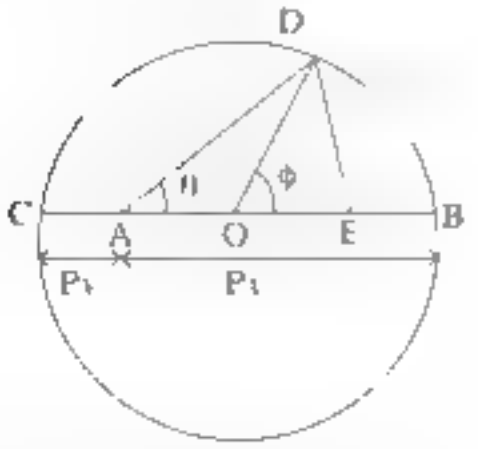



fig $P_x$ tensile and $P_y$ compressive

Taking, $AB = P_x$ and $AC = P_y$

Bisect CB

Draw a circle with O as centre and OB or OC as radius. Draw a line OD at an angle of $2\theta$ to OB join AD

$$\angle DAE = \phi$$

Tengential Stress

$$P_t = DE = OD \sin 2\theta$$

$$OB \sin 2\theta = \frac{P_x - P_y}{2} \sin 2\theta$$

$$\text{Normal Stress } P_n = AE = AG + OE$$

$$= \frac{P_x + P_y}{2} + OD \sin 2\theta$$

$$= \frac{P_x + P_y}{2} + \frac{P_x - P_y}{2} \cos\theta$$

Resultant Stress, $P_r = AD = \sqrt{P_n^2 + P_t^2}$

The maximum value of $P_r$ is equal to the radius of the circle

## Moment of Inertia

The Moment of Inertia of a rigid body about any axis is equal to product of its mass and square of its distance from axis of rotation.

The M I. of a rigid body about a particular axis is defined by the equation

$$I = \Sigma m r^2 = MK^2$$

Here M = Mass of the rigid body

K = Radius of gyration

M I of some areas :

| Shape | Moment of Inertia |
|---|---|
| (1) Rectangle | $I_{xx} = \frac{bd^3}{12}$, $I_{yy} = \frac{db^3}{12}$ |
| (2) Triangle | $I_{xx} = \frac{bh^3}{36}$ $\left(= \frac{bh^3}{12} \text{ about the base}\right)$ |
| (3) Circle | $I_{xx} = I_{yy} = \frac{\pi r^4}{4}$ |
| (4) Semi-circle | $I_{xx} = 0.11 r^4$, $I_{yy} = \frac{\pi r^4}{8}$ |
| (5) Quarter circle | $I_{xx} = I_{yy} = 0.055 r^4$ |
| (6) Ellipse | $I_{xx} = \frac{\pi a b^3}{4}$, $I_{yy} = \frac{\pi a^3 b}{4}$ |

**Theorem of Parallel Axes (or Transfer Formula)** – The moment of inertia of a lamina about any axis in the plane of the lamina equals the sum of moment of inertia about a parallel centroidal axis in the plane of lamina and the

product of the area of the lamina and square of the distance between the two axes.

$$I_{LM} = I_{xx} \text{ (or } I_G) + Ah$$

**Theorem of Perpendicular Axes**—If $Iax$ and $Iay$ be the moment of inertia of a lamina about mutually perpendicular axes OX and OY in the plane of the lamina and I be the moment of inertia of the lamina about an axis normal to the lamina and passing through the point of intersection of the axes OX and OY, then

$$I = I_{ax} + I_{ay}$$

## Lame's Theory

The assumptions made in Lame's theory are as fallows :

1. The material is homogeneous and isotropic.
2. Plane sections perpendicular to the longitudinal axis of the cylinder remain plane after the application of internal pressure.
3. The material is stressed within the elastic limit
4. All the fibres of the material are to expand or contract independently without being constrained by the adjacent fibres

Lame's equations are given by—

$$\sigma_t = \frac{b}{r^2} - a$$

$$\sigma_c = \frac{b}{r^2} + a$$

## Springs

Springs are elastic members which distort under load and regain their original shape when load is removed. They are used in railway carriages, motor cars, scooters, motorcycles, rickshaws, governors etc. According to their uses, the springs perform the following functions :

(i) To absorb shock or impact loading as in carriage springs

(ii) To store energy as in clock springs

(iii) To apply forces to and to control motions as in brakes and clutches

(iv) To measure forces as in spring balances.

(v) To change the variations characteristic of a member as in flexible mounting of motors.

## Column

A column is a long vertical slender bar or vertical member, subjected to an axial compressive load and fixed rigidly at both ends

## Strut

A strut is a slender bar or member in any position other than vertical, subjected to a compressive load and fixed rigidly or hinged or pin jointed at one or both the ends

## Slenderness Ratio (K)

It is the ratio of unsupported length of the column to the minimum radius of gyration of the cross-sectional ends of the column It has no unit whatsoever.

## Buckling Factor

It is the ratio between the equivalent length of the column to the minimum radius of gyration.

## Buckling Load

The maximum limiting load at which the column tends to have lateral displacement or tends to buckle is called buckling or crippling load.

## Safe Load

It is the load to which a column is actually subjected to and is well below the buckling load. It is obtained by dividing the buckling load by a suitable factor of safety

$$\text{Safe Load} = \frac{\text{Buckling load}}{\text{Factor of safety}}$$

## End Conditions

The end conditions of a load can be find in four ways :

(i) Both ends pin jointed or hinged or rounded or free

(ii) One end fixed and other end free.

(iii) One end fixed and other pin jointed.

(iv) Both ends fixed.

## Equivalent Length

The distance between adjacent points of inflexion is called equivalent length or effective length or simple column length. A point of inflexion is found at every column end that is free

to rotate and at every point where there is a change of the axis.

| S.N. | End condition | Equivalent length $l_e$ | Buckling load |
|---|---|---|---|
| 1. | Both ends pin jointed | $l_e = L$ | $\frac{\pi^2 E I}{L^2}$ |
| 2. | One end fixed and the other end pin jointed | $l_e = \frac{L}{\sqrt{2}}$ | $\frac{2\pi^2 E I}{L^2}$ |
| 3. | Both ends fixed | $l_e = \frac{L}{2}$ | $\frac{4\pi^2 E I}{L^2}$ |
| 4. | One end fixed and other end free | $l_e = 2L$ | $\frac{\pi^2 E I}{4L^2}$ |

## Formulae

(1) Relation between modulus of elasticity E and modulus of rigidity C *i.e.*,

$$C = \frac{m}{2(m+1)} E$$

and, $m$ = Constant

(2) Relation between modulus of elasticity E and Bulk modulus K

$$E = 3K\left(1 - \frac{2}{m}\right)$$

(3) Relation between modulus of elasticity, modulus of rigidity and Bulk modulus

$$E = \frac{I K_c}{C + 3K}$$

(4) Euler's Formula (Long columns),

$$P = \frac{\pi^2 EI}{l_e^2}$$

(5) Rankine's formula—

$$P_{Rankine} = \frac{\sigma_c \times A}{1 + a(l_e / K)^2}$$

(6) Johnson's parabolic formula

$$\frac{P}{A} = \sigma_c - b\left(\frac{l}{K}\right)^2$$

Where, $b = \frac{\sigma_c^2}{4\pi^2 E}$

## End Conditions

(i) One end fixed and other end free $l_e = 2\,l$

(ii) Both ends pin joined or hinged or rounded or free $l_e = l$

(iii) One end fixed and other end jointed

$$l_e = \frac{l}{\sqrt{2}}$$

(iv) Both ends fixed $l_e = \frac{l}{2}$

# OBJECTIVE QUESTIONS

1. The combined effect of external forces acting on a body is called—
   (A) Stress (B) Strain
   (C) Load (D) None of the above

2. load is one which is considered to act at a point.
   (A) Triangular
   (B) Uniformly distributed
   (C) Point
   (D) None of the above

3. The internal resistance which the body offers to meet with the load or external force is called –
   (A) Stress
   (B) Strain
   (C) Pressure
   (D) None the above

4. The unit of stress in S.I unit is—
   (A) $MN/m^2$ (B) $KN/mm^2$
   (C) $N/mm^2$ (D) All the above

5. ..... represents the resistance developed by a unit area of cross-section
   (A) Unit stress
   (B) Total stress
   (C) Either of the above
   (D) None of the above

6. Total stress is expressed in—
   (A) N (B) KN
   (C) MN (D) All the above

7. Simple stress is often called—
   (A) Direct stress (B) Transverse stress
   (C) Total stress (D) None of the above

8. The deformation per unit length is called ..
   (A) Strain
   (B) Tensile stress
   (C) Compressive stress
   (D) Shear stress

9. If $l$ and $\delta l$ are the length and change in length respectively the strain is equal to—
   (A) $\frac{\delta l}{l}$ (B) $\frac{l}{\delta l}$
   (C) $l \times \delta l$ (D) None of the above

10. The maximum stress in a ring under tension occurs—
   (A) Along the line of action of load
   (B) Perpendicular to the line of action of load
   (C) At 45° with the line of action of load
   (D) None of the above

11. Which of the following statement is correct with reference to the curved beam theory ?
   (A) Shear stress is zero
   (B) Hoop stress is zero
   (C) Radial stress is zero
   (D) Bending stress is zero

12. The nature of stress at the inside surface of a crane hook is—
   (A) Shear (B) Tensile
   (C) Compressive (D) None of the above

13. For a crane hook the most suitable section is—
   (A) Triangular (B) Trapezoidal
   (C) Circular (D) Rectangular

14. The neutral axis in curved beams—
   (A) Lies at the top of the beam
   (B) Lies at the bottom of the beam
   (C) Coincides with the geometric axis
   (D) Does not coincide

15. In curved beams the distribution of bending stress is—
   (A) Linear (B) Parabolic
   (C) Uniform (D) Hyperbolic

16. A thin flat ring is rotating at a speed $v$. The circumferential stress induced is given by—
   (A) $\rho v_2$ (B) $\rho v^2$
   (C) $\frac{1}{2}\rho v^2$ (D) $\frac{1}{2}\rho v^3$

17. Maximum principal stress theory was postulated by—
   (A) St. Venant (B) Rankine
   (C) Mohr (D) Tresca

18. Maximum shear stress theory was postulated by—
   (A) St. Venant (B) Mohr
   (C) Rankine (D) Tresca

19. Which of the following theories is suitable for ductile material ?
   (A) Maximum principal stress theory
   (B) Maximum principal strain theory
   (C) Maximum shear stress theory
   (D) None of the above

20 .. theory is suitable for brittle material
   (A) Maximum strain energy
   (B) Maximum shear stress theory
   (C) Maximum principal stress theory
   (D) Distortion energy theory

21. Efficiency of the welded joint is ..... than that of the riveted joint.
   (A) Less (B) More
   (C) Both (D) None of the above

22. As compared to a riveted joint a welded joint has ..... strength
   (A) Lesser
   (B) Greater
   (C) Either of the above
   (D) None of the above

23 is a process of joining two pieces of metal by fusion—
   (A) Riveting
   (B) Welding
   (C) Either of the above
   (D) None of the above

24 The diameter of the rivet (d) and thickness of the plate (t) will follow the relation—
   (A) $d = 3\sqrt{t}$ (B) $d = 4\sqrt{t}$
   (C) $d = 5\sqrt{t}$ (D) $d = 6\sqrt{t}$

25 .. riveting is used in structural units.
   (A) Chain (B) Zig-zag
   (C) Diamond (D) None of the above

26. The distance between the centre lines of two rows of rivets is called -
    (A) Pitch (B) Back pitch
    (C) Gauge distance (D) None of the above

27. The diameter of the cold rivet measured before driving is referred as—
    (A) Nominal diameter
    (B) Gross diameter
    (C) Either of the above
    (D) None of the above

28. In a thin shell circumferential stress ($\sigma_c$) is given by—
    (A) $\sigma_c = \frac{Pd}{2n_l}$ (B) $\sigma_c = \frac{Pd}{2m_c}$
    (C) $\sigma_c = \frac{Pd}{tn_l}$ (D) $\sigma_c = \frac{Pd^2}{m_c}$

29. Longitudinal stresses act ..... to the longitudinal axis of the shell.
    (A) Parallel
    (B) Perpendicular
    (C) Either of the above
    (D) None of the above

30 Thin cylinder are frequently required to operate under pressures up to—
    (A) 5 MN/m$^2$ (B) 15 MN/m$^2$
    (C) 30 MN/m$^2$ (D) 250 MN/m$^2$

31. Which of the following is usually considered as thin cylinder ?
    (A) Boilers (B) Tanks
    (C) Steam pipes (D) All the above

32. A shell with wall thickness small compared to internal diameter $\left(\frac{d}{t} \geq 20\right)$ is called .
    (A) Thin shell
    (B) Thick shell
    (C) Either of the above
    (D) None of the above

33 Vessels used for storing fluid under pressure are called
    (A) Cylinders (B) Spheres
    (C) Shells (D) None of the above

34. Chemical vessels are made of which of the following materials ?
    (A) Non-ferrous materials
    (B) Sheet metal
    (C) Cast iron
    (D) Special material

35 Pressure vessels are made of –
    (A) Cast iron
    (B) Sheet steel
    (C) Non-ferrous materials
    (D) Any of the above

36. Where are the steel bars in a concrete beam embedded ?
    (A) In the centre
    (B) Near top section
    (C) Near bottom section
    (D) Uniformly

37 Stress in a beam and the section modulus—
    (A) Have curvilinear relation
    (B) Are inversely proportional
    (C) Are directly proportional
    (D) Have unpredictable relationship

38. When a beam is loaded the horizontal or longitudinal shear should be accounted for materials like—
    (A) Concrete (B) Wood
    (C) Cast iron (D) Lead

39. Neutral plane of a beam—
    (A) Passes through the c.g
    (B) Lies at bottom most fibre
    (C) Is one whose length remains unchanged during the deformation
    (D) None of the above

40. When a rectangular beam is loaded transversely, the maximum compressive stress develops on—
    (A) Neutral axis (B) Top fibre
    (C) Bottom fibre (D) Middle fibre

41 In case of a circular section the section modulus is given on—
    (A) $\frac{\pi d^2}{16}$ (B) $\frac{\pi d^3}{16}$
    (C) $\frac{\pi d^3}{32}$ (D) $\frac{\pi d^4}{64}$

42. The strength of the beam mainly depends on -
    (A) Bending moment
    (B) Centre of gravity of the section
    (C) Section modulus
    (D) Its weight

43. A continuous beam is one which has –
    (A) Less than two supports
    (B) Two supports only
    (C) More than two supports
    (D) None of the above

44. In which of the following beam the supports are not situated at the ends ?
    (A) Cantilever beam
    (B) Simply supported beam
    (C) Over hanging beam
    (D) None of the above

45. A cantilever is a beam whose—
    (A) One end is fixed and other free
    (B) Both ends are fixed
    (C) Both ends are free
    (D) None of the above

46. The moment of inertia of a rectangle about its XX-axis is given by—
    (A) $\frac{bd^3}{12}$ (B) $\frac{db^3}{12}$
    (C) $\frac{d^3b}{6}$ (D) $\frac{bd^3}{6}$

47. The moment of inertia of a semicircle about its XX-axis is—
    (A) $0{\cdot}22\,r^3$ (B) $0{\cdot}11\,r^4$
    (C) $0{\cdot}14\,r^4$ (D) $0{\cdot}2\,r^4$

48. The moment of inertia of a quadrant about its XX-axis is given by—
    (A) $0{\cdot}055\,r^4$ (B) $0{\cdot}04\,r^4$
    (C) $0{\cdot}06\,r^4$ (D) $r^4$

49. The moment of inertia about a principal axis is called—
    (A) Mass moment of inertia
    (B) Second moment of inertia
    (C) Principal moment of inertia
    (D) Any of the above

50. The impact strength of a material is an index of its—
    (A) Resistance to corrosion
    (B) Hardness
    (C) Toughness
    (D) None of the above

51. When mild steel is subjected to tensile loading, its fracture will conform to ..... shape.
    (A) Granular (B) Cup and cone
    (C) Star (D) None of the above

52 The limiting load beyond which the material does not behave elastically is known as—
    (A) Upper yield point
    (B) Maximum stress point
    (C) Proportional limit
    (D) Elastic limit

53. In which of the following terms stiffness is expressed ?
    (A) Impact strength
    (B) Modulus of elasticity
    (C) Hardness number
    (D) Mass density

54. During tensile test, what does percentage elongation indicate ?
    (A) Malleability (B) Fatigue strength
    (C) Ductility (D) Creep

55 The value of Poisson's ratio depends upon—
    (A) Cross section
    (B) Magnitude of load
    (C) Material of test specimen
    (D) None of the above

56 .. has the highest value of Poisson's ratio–
    (A) Concrete (B) Wood
    (C) Steel (D) Rubber

57. If a part is constrained to move and heated it will develop ..... stress
    (A) Shear (B) Tensile
    (C) Principal (D) Compressive

58. The impact strength of a material is an index of its—
    (A) Hardness (B) Tensile strength
    (C) Toughness (D) None of the above

59. If the radius of a wire stretched by a load is doubled, then its Young's modulus will be—
    (A) Halved
    (B) Doubled
    (C) Become one-fourth
    (D) Remain unaffected

60. The material having same elastic properties in all directions are called ..... material
(A) Elastic (B) Isotropic
(C) Ideal (D) Uniform

61. strain is the deformation of the bar per unit length in the direction of the force.
(A) Volumetric (B) Shear
(C) Lateral (D) Linear

62. The temperature strain in a bar is ..... proportional to the change in temperature.
(A) Directly
(B) Indirectly
(C) (A) or (B)
(D) None of the above

63. Poisson's ratio for aluminium is—
(A) 0·13 (B) 0·23
(C) 0·33 (D) 0·43

64. The ratio of lateral strain to linear strain is known as—
(A) Modulus of elasticity
(B) Modulus of rigidity
(C) Poisson's ratio
(D) Elastic limit

65. To measure ..... strain rosetters are used
(A) Linear (B) Shear
(C) Volumetric (D) None of the above

66 When two equal and opposite forces applied to a body, tend to elongate it, the body is said to be in—
(A) Compression (B) Tension
(C) Shear (D) Unpredictable

67. The strain produced due to shear force is known as—
(A) Tensile strain
(B) Compressive strain
(C) Shear strain
(D) Volumetric strain

68. Working stress is always—
(A) Less than ultimate stress
(B) More than ultimate stress
(C) Equal to ultimate stress
(D) None of the above

69. A measure of the strength economy of a material is the ratio between –
(A) Working strength and density
(B) Ultimate strength and density
(C) Ultimate strength and safety
(D) None of the above

70. The thermal stress in a bar is directly proportional to—
(A) Its cross sectional area
(B) Its volume
(C) The change in temperature
(D) None of the above

71 The stress produced by a suddenly applied load as compared to that produced by the same load when applied gradually is—
(A) Double (B) Equal
(C) Half (D) Four times

72. The value of Poisson's ratio depends on the—
(A) Size of material
(B) Type of material
(C) Magnitude of load
(D) Nature of load

73 The principal stress are—
(A) Parallel to the principal planes
(B) Normal to the principal planes
(C) Inclined to the principal planes
(D) None of the above

74. The point in a beam where the shear force is zero, the value of bending moment at that point is—
(A) Maximum (B) Zero
(C) Minimum (D) Infinite

75 The point of contraflexure occurs in—
(A) Simply supported beams
(B) Over hanging beam
(C) Cantilevers
(D) All the above

76 In case of over hanging beam the point of contraflexure—
(A) Always lies within the supports
(B) Always lies in the overhanging portion
(C) Both
(D) None of the above

77. A roller support has—
(A) Reaction in two directions
(B) Inclined reaction
(C) Reaction normal to the direction of motion
(D) None of the above

78. In S.I. system the unit of torque is—
(A) Kg.m (B) Kg/cm$^2$
(C) Newton metre (D) Dynes

79. The type of stresses set up in a rotating shaft due to torsion are—
(A) Shear (B) Compressive
(C) Bending (D) All the above

80 The intensity of shear stress in a shaft subjected to torsion is maximum at—
(A) Its axis (B) Its outer layer
(C) Any layer (D) None of the above

81. The most economical section of the shaft subjected to torsion is—
(A) Square section (B) Elliptical section
(C) Solid circular (D) Hollow circular

82 The critical load of column is defined as the load at which column is in—
(A) Stable equilibrium
(B) Neutral equilibrium
(C) Unstable equilibrium
(D) None of the above

83 When a long column is subjected to a load more than critical, the column becomes—
(A) Unstable (B) Stable
(C) Neutral (D) None of the above

84. The ratio of length of strut and least radius of gyration is known as—
(A) Poisson's ratio (B) Slenderness ratio
(C) Factor of safety (D) None of the above

85 The buckling load in case of struts is given by the relation—
(A) $\frac{\pi^2 E I}{l_e^2}$ (B) $\frac{4 \pi^2 E I}{l_e^2}$
(C) $\frac{2 \pi^2 E I}{l_e^2}$ (D) $\frac{\pi^2 E I}{4 l_e^2}$

86. The method of reducing the hoop stresses in cylinders is—
(A) To make its ends flat
(B) To shrink one cylinder over the other
(C) Both (A) and (B)
(D) None of the above

87 The loop stresses are acting across the—
(A) Circumferential section
(B) Longitudinal section
(C) Radial section
(D) None of the above

88. The thickness of cylindrical shell is designed on the basis of—
(A) Diameter of the shell
(B) Length of the shell
(C) Loop stress
(D) None

89. Thick cylinders are used to resist the pressure above—
(A) 100 Kg/cm$^2$ (B) 1000 Kg/cm$^2$
(C) 2500 Kg/cm$^2$ (D) None of the above

90. The strength of welded joint is equal to—
(A) 0·5 af. (B) 0·9 af.
(C) 0·7 af. (D) 0·0007 af.

91 The shearing strength of a rivet in double shear as compared to rivet in single shear is—
(A) 1·5 times (B) 1·8 times
(C) Double (D) 1·2 times

92. The diameter of a hole drilled in a plate as compared to shank diameter of a rivet is—
(A) Less (B) More
(C) Equal (D) None of the above

93. A rivet joint may fail due to—
(A) Tearing of the plate
(B) Shearing of rivets
(C) Crushing of rivets
(D) Any one of the above

94. The efficiency of a single rivetted lap joint is –
(A) 30% (B) 40%
(C) 55% (D) 80%

95. In a welded lap joint the throat thickness is equal to—
(A) 0·4 x Size of the weld
(B) 0·5 x Size of the weld
(C) 0·7 x Size of the weld
(D) None of the above

96. In a welded butt joint the throat thickness as compared to the plates thickness is—
(A) Equal (B) Less
(C) More (D) None of the above

97. The property of material to withstand deformation without fracture is known as—
(A) Plasticity (B) Toughness
(C) Brittleness (D) Ductility

98. The property of material which allows it to deform without fracture is known as—
(A) Brittleness (B) Toughness
(C) Elasticity (D) Plasticity

99. The shape of specimen in a compression test is—
(A) Cubical (B) Cylindrical
(C) Spherical (D) Conical

100. The behaviour of metals under the action of cyclic stresses is termed as—
(A) Creep (B) Fatigue
(C) Endurance (D) None of the above

101. A simply supported beam of length 'L' carrying a load concentrated at the centre of span will have maximum bending moment of—
(A) WL (B) $\frac{WL}{3}$
(C) $\frac{WL}{4}$ (D) $\frac{WL}{16}$

102 The loss of strength in compression with simultaneous gain in strength in tension due to overloading is known as—
(A) Creep
(B) Bauschinger effect
(C) Visco-elasticity
(D) Hysterisis

103 The point of contraflexure occurs in—
(A) Cantilever beam only
(B) Simply supported beam only
(C) Overhanging beam only
(D) Continuous beam only

104 A simply supported beam of length 'L', cross section 'A' carrying a uniformly distributed total load of 'W' will have maximum bending moment of –
(A) $\frac{WL}{4}$ (B) $\frac{WL}{8}$
(C) $\frac{WL}{16}$ (D) $\frac{WL}{24}$

105 The numerical values of Young's modulus of elasticity in descending order for wood, lead, glass, steel and phosphor bronze is given by—
(A) Steel, glass, phosphor bronze, lead, wood
(B) Steel, phosphor bronze, wood, glass, lead
(C) Steel, lead, wood, phosphor bronze, glass
(D) Steel, phosphor bronze, glass, lead and wood

106 The average value of modulus of rigidity for Aluminium, Brass, Copper, Nickel and Steel in descending order are given by—
(A) Steel, Nickel, Copper, Brass, Aluminium
(B) Brass, Copper, Aluminium, Nickel, Steel
(C) Aluminium, Brass, Copper, Nickel, Steel
(D) Aluminium, Copper, Nickel, Brass, Steel

107 A reinforced concrete beam is considered to be made of—
(A) Homogeneous material
(B) Hetrogeneous material
(C) Clad material
(D) Composite material

108. The deflection of a cantilever beam of effective length 'L', moment of inertia I (modulus of elasticity E) when subjected to load 'W' at the free end will be—
(A) $\frac{WL^3}{3EI}$ (B) $\frac{WL^3}{8EI}$
(C) $\frac{WL^3}{24EI}$ (D) $\frac{WL^3}{48EI}$

109 In a beam where shear force is maximum, the bending moment will be—
(A) Zero
(B) Maximum
(C) Minimum
(D) There is no such relation between them

110 For a thin cylinder the ratio longitudinal stress/ hoop stress is—
(A) 1 (B) $\frac{1}{4}$
(C) $\frac{1}{2}$ (D) 2

111. Rivets are generally specified by—
(A) Shape (B) Diameter of head
(C) Over all length (D) Shank diameter

112. A column is known as short column if
(A) Slenderness ratio is more than 120
(B) The slenderness ratio is more than 32
(C) The length is more than 30 times the diameter
(D) The length is less than 8 times the diameter

113. A column that fails primarily due to direct stress is called—
(A) Short column (B) Long column
(C) Weak column (D) Medium column

114. The stiffness of a closely coiled spring of '$n$' coils of wire of diameter '$d$', spring radius 'R', is given by—
(A) $\frac{Cd^3}{R^2n}$ (B) $\frac{Cd^8}{16R^3n^3}$
(C) $\frac{Cd^4n}{32R^3}$ (D) $\frac{Cd^4}{64R^3n}$

115 A cylindrical section having no joint is known as—
(A) Jointless section (B) Seamless section
(C) Perfect section (D) Strong section

## Answers

| | | | | |
|---|---|---|---|---|
| 1 (C) | 2 (C) | 3 (A) | 4 (D) | 5 (A) |
| 6. (D) | 7 (A) | 8 (A) | 9 (A) | 10. (A) |
| 11 (C) | 12 (B) | 13 (B) | 14 (C) | 15 (D) |
| 16. (B) | 17. (B) | 18. (D) | 19. (C) | 20. (C) |
| 21 (B) | 22 (B) | 23 (B) | 24 (D) | 25 (C) |
| 26. (B) | 27. (A) | 28. (A) | 29. (A) | 30. (C) |
| 31. (D) | 32. (A) | 33. (C) | 34 (D) | 35. (D) |
| 36. (C) | 37. (B) | 38. (B) | 39. (C) | 40. (B) |
| 41 (C) | 42 (C) | 43 (C) | 44 (C) | 45 (A) |
| 46. (A) | 47. (B) | 48. (A) | 49 (C) | 50. (C) |
| 51. (B) | 52. (D) | 53. (B) | 54. (C) | 55. (C) |
| 56. (D) | 57 (D) | 58 (C) | 59 (D) | 60. (A) |
| 61 (D) | 62 (A) | 63 (C) | 64 (C) | 65 (A) |
| 66 (B) | 67 (C) | 68 (A) | 69. (C) | 70 (C) |
| 71 (A) | 72. (B) | 73. (B) | 74. (A) | 75 (B) |
| 76. (A) | 77. (C) | 78. (C) | 79. (A) | 80. (B) |
| 81. (D) | 82. (B) | 83. (A) | 84. (B) | 85. (A) |
| 86 (B) | 87. (B) | 88. (C) | 89. (C) | 90. (C) |
| 91. (B) | 92. (B) | 93. (D) | 94. (C) | 95. (C) |
| 96. (A) | 97 (B) | 98 (D) | 99 (B) | 100 (B) |
| 101 (C) | 102 (B) | 103 (C) | 104 (B) | 105. (D) |
| 106 (C) | 107 (B) | 108 (A) | 109 (B) | 110. (C) |
| 111 (D) | 112 (D) | 113 (A) | 114. (D) | 115. (D) |

# 5 FLUID MECHANICS

## Properties of Fluid

(1) Hydraulics is that branch of Engineering which deals with water (at rest or in motion).

(2) Fluid mechanics may be defined as that branch of Engineering which deals with the behaviour of fluid under the conditions of rest and motion.

(3) A fluid is a substance which is capable of flowing.

(4) Specific gravity is the ratio of the specific weight of the liquid to the specific weight of a standard fluid. It is dimensionless and has no units.

(5) Viscosity is the property of a fluid which determines its resistance to shearing stresses

(6) **Cohesion and Adhesion**—Cohesion means intermolecular attraction between molecules of the same liquid.

Adhesion means attraction between the molecules of a liquid and the molecules of a solid boundary surface in contact with the liquid

(7) **Surface Tension ($\sigma$)**—Surface tension is caused by the force of cohesion at the free surface It is expressed in N/m.

Pressure inside :

(i) Water droplet $P = \frac{4\sigma}{d}$

(ii) Soap bubble $P = \frac{8\sigma}{d}$

(iii) Liquid jet $P = \frac{2\sigma}{d}$

Where $d$ stands for diameter

## Buoyancy and Floatation

The tendency for an immersed body to be lifted up in the fluid, due to an upward force opposite to action of gravity is known as buoyancy.

The floating bodies may have the following types of equilibrium

(i) Stable equilibrium

(ii) Unstable equilibrium

(iii) Neutral equilibrium

## Metacentre

The metacentre is defined as a point of intersection of the axis of body passing through c.g. (G) and original centre of buoyancy (B) and a vertical line passing through the centre of buoyancy ($B_1$) of the position of the body.

The distance between the centre of gravity (G) of a floating body and the metacentre (M) is called metacentric height.

## Fluid Kinematics

Fluid kinematics is a branch of fluid mechanics which deals with the study of velocity and acceleration of the particles of fluids in motion and their distribution in space without considering any force or energy involved

The motion of fluid particles may be described by the following methods.

(1) **Langrangian Method**—In this method the observer concentrates on the movement of a single particle The path taken by the particle and change in velocity and acceleration are studied

(2) **Eulerian Method**—In Eulerian method the observer concentrates on a point in the fluid system velocity, acceleration and other characteristics of the fluid at that particular point are studied

## Types of Fluid Flow

(i) Steady and unsteady flows.

(ii) Uniform and non-uniform flows.

(iii) One, two and three-dimensional flows.

(iv) Rotational and irrotational flows.

(v) Laminar and turbulent flows.

(vi) Compressible and incompressible flows

## Types of Flow Lines

(i) **Path line**—It is the path followed by a fluid particle in motion.

(ii) **Stream line**—It is an imaginary line within the flow so that the tangent at any point on it indicates the velocity at that point.

(iii) **Stream tube**—It is a fluid mass bounded by a group of streamlines.

(iv) **Streak line**—It is a curve which gives an instantaneous picture of the location of the fluid particles, which have passed through a given point.

## Bernoulli's Theorem

According to this theorem "The total energy of a small amount of non-viscous and incompressible liquid flowing from one point to another, remains constant throughout the displacement". *i.e.*

$$P + \rho g h + \frac{1}{2}\rho v^2 = \text{Constant}$$

## Stoke's law

When a bob (spherical ball) is dropped into a stationary liquid then it speeds up liquid in its contact, but remaining liquid remains at rest, which exerts an upward force called viscous drag Thus force F depends upon the radius of the bob ($r$), coefficient of viscosity of liquid ($\eta$) and viscosity of bob relative to liquid (V).

$$\therefore \qquad F = 6\pi\eta rV$$

This relation is known as Stoke's law

## Archimede's Principle

It states that when a body is fully or partially immersed in a fluid it is lifted up by a force which is equal to the weight of the fluid displaced.

## Conditions of Equilibrium of Floating Bodies

(i) **Stable Equilibrium**—If 'M' lies above G *i.e.*, BM > BG or MG > O.

(ii) **Unstable Equilibrium** – If 'M' lies below G *i.e.*, BM < BG or MG < O.

(iii) **Neutral Equilibrium**—The metacentre will coincide with the centre of gravity

## Reynolds Number

It is defined as the ratio of inertia force and viscous force of a flowing fluid. It is given by

$$R_e = \frac{\rho VL}{\mu} = \frac{VL}{\nu} = \frac{V \times d}{\nu} \quad \text{(for pipe flow)}$$

Where V = Velocity of flow

$d$ = Diameter of the pipe

and $\nu$ = Kinematic viscosity of the fluid.

## Flow Through Orifices and Mouthpieces

(1) An orifice is an opening in the wall or base of a vessel through which the fluid flows. The top edge of the orifice is always below the free surface.

A mouthpiece is an attachment in the form of a small tube or pipe fixed to the orifice (the length of pipe extension is usually 2 to 3 times the orifice diameter) and is used to increase the amount of discharge

The velocity of jet of water from orifice is given as

$$V = \sqrt{2gH}$$

## Notch and Weirs

A notch may be defined as an opening provided in the side of a tank or vessel such that the liquid surface in the tank is below the top edge of the opening.

A weir may be defined as any regular obstruction in an open stream over which the flow takes place

## Laminar Flow

Reynolds number

$R_e < 2000$ ...Laminar flow

Reynolds number

$R_e > 4000$ ...Turbulent flow

**In case of Laminar flow**—

The loss of head $\propto V$

Where V is the velocity of flow

**In case of Turbulent flow**—The loss of head $\alpha$

$V^2$ (approx.) $\propto V^n$ (more exactly)

Where $n$ varies from 1·75 to 2·0

## Flow in Open Channels

An open channel may be defined as a passage in which liquid flows with its upper surface exposed to atmosphere.

The flow in the open channel may be characterised as laminar or turbulent depending upon the value of Reynolds number.

When $R_e < 500$ ... flow is laminar

When $R_e > 2000$ ... flow is turbulent

When $500 > R_e < 2000$... flow is transitional

## Hydraulic Turbines

A hydraulic turbines is a prime mover that uses the energy of flowing water and converts it into the mechanical energy (in the form of rotation of the runner).

## Hydraulic Machines

(i) **The Hydraulic accumulator** is a device used to store the energy of fluid under pressure and make this energy available to hydraulic machines such as presses, lifts and cranes.

(ii) **A differential accumulator** is a special type of accumulator that is used for storing energy at high pressure by comparatively small load on the ram

(iii) **Hydraulic intensifier** is a device which increases the intensity of pressure of a given liquid with the help of low pressure liquid of large quantity

(iv) **Hydraulic press** is a device used for lifting heavy loads by the application of much smaller force It is based on Pascal`s law

(v) **Hydraulic crane** is a device which is used for lifting heavy loads (upto 25 MN)

(vi) **Hydraulic lift** is a device used for carrying persons and loads from one floor to another.

(vii) **Hydraulic ram** is a device with which small quantities of water can be pumped to higher levels from the available large quantity of water of low head

# OBJECTIVE QUESTIONS

1. The branch of engineering science, which deals with water at rest or in motion is called—
   (A) Hydraulics
   (B) Fluid mechanics
   (C) Applied mechanics
   (D) Kinematics

2. A solid can resist which of the following stresses ?
   (A) Tensile (B) Compressive
   (C) Shear (D) All the above

3 .. possesses no definite volume and is compressible.
   (A) Solid (B) Liquid
   (C) Gas (D) Vapour

4. A real practical fluid possesses which of the following ?
   (A) Viscosity
   (B) Surface tension
   (C) Density
   (D) All of the above

5. The ratio of the specific weight of the liquid to the specific weight of a standard fluid is known as—
   (A) Specific volume (B) Weight density
   (C) Specific gravity (D) Viscosity

6. The property of a fluid which determines its resistance to shearing stresses is called—
   (A) Viscosity (B) Surface tension
   (C) Compressibility (D) None of the above

7. Newton's law of viscosity is given by the relation—
   (A) $\tau = \mu^2 \frac{du}{dy}$ (B) $\tau = \sqrt{\mu} \frac{du}{dy}$
   (C) $\tau = \mu \frac{du}{dy}$ (D) $\tau = \mu^{3/2} \frac{du}{dy}$

8. Fluids which do not follow the linear relationship between shear stress and rate of deformation are termed as ..... fluids
   (A) Newtonian
   (B) Non-Newtonian
   (C) Dualent
   (D) Ideal

9. The printer's ink is an example of –
   (A) Newtonian fluid
   (B) Non-Newtonian fluid
   (C) Thyxotropic substance
   (D) Elastic solid
10. The viscosity of liquids . with increase in temperature—
   (A) Decreases
   (B) Increases
   (C) Both (A) and (B)
   (D) None of the above
11. Surface tension is caused by the force of ..... at the free surface.
   (A) Cohesion (B) Adhesion
   (C) Both (D) None of the above
12. Which of the following is an example of phenomenon of surface tension ?
   (A) Rain drops
   (B) Rise of sap in a tree
   (C) Break up of liquid jets
   (D) All of the above
13 Surface tension is expressed in—
   (A) N/m (B) $N/m^2$
   (C) $N^2/m$ (D) $N/m^3$
14. Pressure inside a water droplet is given by the relation—
   (A) $P = \frac{4\sigma}{d}$ (B) $P = \frac{3\sigma}{d}$
   (C) $P = \frac{8\sigma}{d}$ (D) $P = \frac{16\sigma}{d}$
15. is a phenomenon by which a liquid rises into a thin glass tube above or below its general level
   (A) Surface tension (B) Capillarity
   (C) Cohesion (D) Adhesion
16. The capillary rise of water in the glass tube is given by—
   (A) $h = \frac{2\sigma}{w\,d}$ (B) $h = \frac{3\sigma}{w\,d}$
   (C) $h = \frac{4\sigma}{w\,d}$ (D) $h = \frac{6\sigma}{w\,d}$
17. The force per unit area is called—
   (A) Pressure (B) Strain
   (C) Surface tension (D) None of the above
18. The pressure of a liquid on a surface will always act ..... to the surface.
   (A) Parallel (B) Normal
   (C) 45° (D) 60°
19. The pressure ..... as the depth of the liquid increases.
   (A) Increases
   (B) Decreases
   (C) Remains unchanged
   (D) None
20. The intensity of pressure in a liquid due to its depth will vary ..... with depth
   (A) Directly (B) Indirectly
   (C) Both (D) None of the above
21. The height of the free surface above any point is known as—
   (A) Static head
   (B) Intensity of pressure
   (C) Both (A) and (B)
   (D) None of the above
22. The term fluid is applied to substances which—
   (A) Offer no resistance to change of shape
   (B) Offer resistance to change of shape
   (C) Offer least resistance to compression
   (D) None of the above
23. The pressure of a fluid on a surface act—
   (A) Normal to the surface
   (B) Normal to the sphere
   (C) Parallel to the surface
   (D) None of the above
24 Poise is a unit of—
   (A) Surface tension (B) Viscosity
   (C) Specific weight (D) Pressure
25. The intensity of pressure at a depth $h$ is equal to—
   (A) Specific weight x Depth
   (B) Specific volume x Depth
   (C) Density x Depth
   (D) Force x Depth
26. The resultant pressure (P) of the liquid on a immersed surface will act at—
   (A) A point of centre of gravity
   (B) The lower edge of the surface
   (C) The upper edge of the surface
   (D) None of the above

27 The depth of the centre of pressure ($h$) is given by relation –

(A) $h = I_0 A\bar{x}$ (B) $h = \frac{I_0}{A\bar{x}}$

(C) $h = \frac{I_0\bar{x}}{A}$ (D) $h = \frac{I_0 A}{\bar{x}}$

28. The pressure of fluid can be measured by a –
(A) Barometer (B) Manometer
(C) Piezometer tube (D) All of the above

29. The point of application of buoyant force is known as—
(A) Centre of pressure
(B) Centre of buoyancy
(C) Centre of gravity
(D) None of the above

30 The body is said to be floating when—
(A) $W > F_b$ (B) $W = F_b$
(C) $W < F_b$ (D) None of these

31. According to principle of floatation the weight of liquid displaced as compared to the weight of the body is—
(A) More (B) Less
(C) Same (D) None of the above

32 The stability of a floating body depends upon—
(A) Its volume
(B) Its weight
(C) Its metacentric height
(D) The specific weight of fluid

33 The metacentric height of sailing ships is—
(A) 0·45 m to 1·25 m
(B) 1·5 m to 3 5 m
(C) 0·25 m to 0·35 m
(D) 5 m to 7·5 m

34. The metacentric height of battle ships is—
(A) 0·3 m to 0·8 m (B) 1·0 m to 1·5 m
(C) 2·5 m to 3 5 m (D) 5·0 m to 6·0 m

35 A manometer is used to measure—
(A) Velocity of flow in channel
(B) Atmospheric pressure
(C) Pressure in pipes
(D) None of the above

36. A differential manometer is used to measure
(A) Difference of pressure at two sections of a pipe
(B) Atmospheric pressure
(C) Absolute pressure
(D) Velocity of fluid in pipes

37. A small hole in the side or base of a tank is termed as—
(A) Notch (B) Orifice
(C) Mouthpiece (D) Downed orifice

38 A venturimeter is used to measure discharge through—
(A) A pipe (B) An open channel
(C) A weir (D) Notch

39. The diameter of throat of a venturimeter as compared to inlet diameter is generally—
(A) Half (B) One fourth
(C) Double (D) One eighth

40. In order to avoid separation in venturimeter the angle of divergence is kept—
(A) 10° to 15° (B) 15° to 20°
(C) 5° to 7° (D) 7° to 10°

41 The discharge through a pipe can be measured with—
(A) A venturimeter (B) An orificameter
(C) A flow nozzle (D) All of the above

42 The loss of head due to sudden contraction is equal to—
(A) $0{\cdot}75\frac{v^2}{2g}$ (B) $0{\cdot}75\frac{v^2}{4g}$
(C) $1{\cdot}5\frac{v^2}{g}$ (D) $0{\cdot}25\frac{v^2}{2g}$

43. The length of mouthpiece as compared to diameter is—
(A) 5 to 6 times (B) 6 to 8 times
(C) 2 to 3 times (D) 1 to 1·5 times

44. The angle of contact ($\theta$) between mercury and glass tube in case of capillary depression is—
(A) 5° (B) 15°
(C) 95° (D) 128°

45. The reciprocal of Euler's number is known as –
(A) Mach's number
(B) Newton's number
(C) Weber's number
(D) Froude's number

46. The Reynolds number for laminar flow in circular pipes is less than—
(A) 5000 (B) 3000
(C) 2000 (D) 8000

47. The frictional resistance is independent of—
(A) Velocity of flow
(B) Temperature of fluid
(C) Pressure of flow
(D) Area of surface in contact

48. The frictional resistance in case of turbulent flow is independent of—
(A) Area of surface in contact
(B) Density of fluid
(C) Temperature of fluid
(D) Pressure of flow

49 The head lost due to turbulent flow as compared to head lost in laminar flow is—
(A) 100 times (B) 200 times
(C) 320 times (D) 480 times

50 According to Nikuradse's the boundary behaves hydrodynamically smooth when—
(A) $\frac{k}{\delta} > 10$ (B) $\frac{k}{\delta} > 0{\cdot}25$
(C) $\frac{k}{\delta} < 0{\cdot}25$ (D) $\frac{k}{\delta} < 8$

51 The value of critical velocity is governed by the—
(A) Inertia force
(B) Viscous force
(C) Ratio of inertia force and viscous force
(D) None of the above

52. The lower critical Reynolds number is approximately equal to—
(A) 100 (B) 200
(C) 1000 (D) 2000

53. The head loss due to turbulent flow as compared to laminar flow is—
(A) Less (B) More
(C) Equal (D) Unpredictable

54. The kinematic viscosity 'ε' is given by the relation –
(A) $\varepsilon = \frac{\eta}{\rho}$ (B) $\varepsilon = \eta\rho$
(C) $\varepsilon = \frac{\rho}{\eta}$ (D) $\varepsilon = \rho + \eta$

55. The motion of whirlpool in a river is—
(A) Rectilinear (B) Radial
(C) Forced vortex (D) Free vortex

56. In a stream line flow the component of viscosity at right angle to the streamline is—
(A) Maximum (B) Minimum
(C) Zero (D) Unpredictable

57. If the flow parameters change with time it is known as—
(A) Uniform flow
(B) Unsteady flow
(C) Steady flow
(D) None of the above

58. The coefficient of friction in terms of Reynolds number is equal to—
(A) $\frac{16}{R_e}$ (B) $\frac{32}{R_e}$
(C) $\frac{8}{R_e}$ (D) $\frac{10}{R_e}$

59. If a thin plate is held parallel to a fluid stream, the pressure drag on it is—
(A) Maximum (B) Minimum
(C) Zero (D) None of the above

60. If a thin plate is held normal to the flow, the viscous drag on it is—
(A) Maximum (B) Minimum
(C) Zero (D) None of the above

61 The total drag on a plate held normal to the flow is equal to—
(A) Pressure drag (B) Viscous drag
(C) $\frac{\text{Viscous drag}}{\text{Pressure drag}}$ (D) None of the above

62. The coefficient of drag and lift are functions of—
(A) Frouds number
(B) Reynolds number
(C) Weber number
(D) Euler number

63. The line joining the leading and trailing of the airfoil is known as –
(A) Profile centre line
(B) Chord line
(C) Camber line
(D) Curvature line

64. The aspect ratio of a wing is expressed as—
(A) $\frac{l}{A}$ (B) $\frac{l^2}{A}$
(C) $\frac{l}{A^2}$ (D) $\frac{l^2}{A^2}$
$l$ = Span, A = Area

65. The coefficient of lift at stall point is—
(A) Maximum (B) Minimum
(C) Zero (D) Average

66. The maximum velocity of an airplane in steady level flight will occur at an angle of attack of—
(A) 20·5° (B) 18·5°
(C) 22·5° (D) 26·5°

67. The weir with thick crest is known as—
(A) Drowned weir
(B) Broad crested weir
(C) Suppressed weir
(D) Cippoletti weir

68. The cross section of cippoletti weir is—
(A) Rectangular (B) Triangular
(C) Trapezoidal (D) None of the above

69 The critical depth of a channel is expressed as—
(A) $h_c = \frac{V}{g}$ (B) $h_c = \frac{V^2}{g}$
(C) $h_c = \frac{V^2}{2g}$ (D) None of the above

70. The critical depth of a channel is equal to—
(A) $\frac{1}{2}E_{min}$ (B) $\frac{2}{3}E_{min}$
(C) $\frac{3}{2}E_{min}$ (D) $\frac{1}{4}E_{min}$

71. The velocity for which the specific energy is minimum is known as—
(A) Maximum velocity
(B) Minimum velocity
(C) Critical velocity
(D) Average velocity

72. The condition for a tranquil flow in a channel is
(A) $h > \frac{v^2}{g}$ (B) $h = \frac{v^2}{g}$
(C) $h < \frac{v^2}{g}$ (D) None of the above

73. Hydraulic jump is a phenomenon occurring in—
(A) A pipe
(B) A closed channel
(C) An open channel
(D) None of the above

74 The wave produced due to surface tension in a shallow channel is known as—
(A) Gravity wave (B) Capillary wave
(C) Elastic wave (D) None of the above

75 In case of depressed nappe the pressure of air below the nappe is—
(A) Less than atmospheric
(B) More than atmospheric
(C) Equal to atmospheric
(D) None of the above

76. When there is no air left below the nappe, it is known as—
(A) Free nappe (B) Depressed nappe
(C) Adhering nappe (D) All of the above

77. The hydraulic accumulator is fitted—
(A) In between the pump and machine
(B) Before the pump
(C) After the machine
(D) Cannot be fitted anywhere

78. The intensifier can raise the pressure of water upto—
(A) 100 kg/cm$^2$ (B) 560 kg/cm$^2$
(C) 950 kg/cm$^2$ (D) 1600 kg/cm$^2$

79. The pressure of water in a pelton wheel is—
(A) Less than atmosphere
(B) More than atmosphere
(C) Equal to atmosphere
(D) None of the above

80. Which one is an impulse turbine ?
(A) Kaplan turbine (B) Francis turbine
(C) Pelton wheel (D) Fourneyron

81 Pelton wheel is a—
(A) Tangential flow turbine
(B) Radial flow turbine
(C) Axial flow turbine
(D) None of the above

82. Which one of the following is an axial flow turbine ?
(A) Pelton wheel (B) Francis turbine
(C) Kaplan turbine (D) None of the above

83. The type of turbine recommended for a head of 10 metre is—
(A) Francis turbine (B) Kaplan
(C) Pelton wheel (D) None

84. A Girard turbine is—
(A) An axial flow reaction turbine
(B) An axial flow impulse turbine
(C) An inward flow reaction turbine
(D) None of the above

85. In case of reaction turbine—
(A) $P_1 = P_2$ (B) $P_1 > P_2$
(C) $P_1 < P_2$ (D) None of the above

86. The Banki turbine is generally employed for a head upto—
(A) 100 m (B) 500 m
(C) 20 m (D) 600 m

87. In a reciprocating pump the accelerating head is maximum at the—
(A) Beginning of stroke
(B) End of stroke
(C) Mid of stroke
(D) None of the above

88. A single impeller pump deliver the discharge against a maximum head of—
(A) 10 m (B) 100 m
(C) 200 m (D) 500 m

89. The no. of blades in a Kaplan turbine are—
(A) 4 – 6 (B) 10 – 12
(C) 20 – 24 (D) 25 – 30

90. The unit speed of a turbine is equal to—
(A) $\frac{N}{\sqrt{H}}$ (B) $N\sqrt{H}$
(C) $\frac{\sqrt{H}}{N}$ (D) $\frac{2N}{\sqrt{H}}$

91. The unit power of a turbine is equal to—
(A) $\frac{P}{H^{5/2}}$ (B) $\frac{P}{H^{1/2}}$
(C) $\frac{P}{H^{3/2}}$ (D) $\frac{P}{H^{2/5+1/2}}$

92 The head of water required for pelton wheel is—
(A) Low
(B) Medium
(C) High
(D) None of the above

93 The overall efficiency of pelton wheel is about—
(A) 55% (B) 65%
(C) 85% (D) 99%

94. The function of a hydraulic turbine is to convert water energy into—
(A) Heat energy
(B) Electrical energy
(C) Machanical energy
(D) Atomic energy

95. The suction pressure in a reciprocating pump, to avoid separation must not exceed—
(A) 2·6 m of water
(B) 7·7 m of water
(C) 10 m of water
(D) 3 m of water

96. A pitot tube is used to measure—
(A) Discharge through a pipe
(B) Velocity of flow
(C) Specific gravity
(D) Viscosity

97. The hydraulic mean depth for a rectangular section is—
(A) $\frac{bd}{2d+b}$ (B) $\frac{bd}{d+b}$
(C) $\frac{2bd}{d+b}$ (D) $\frac{bd}{2(d+b)}$

98. The hydraulic mean depth for a pipe running full of water is equal to—
(A) $\frac{d}{2}$ (B) $\frac{d}{4}$
(C) $2d$ (D) $2\pi d$

99. The thickness of the boundary layer at the leading edge of the body is—
(A) Maximum (B) Minimum
(C) Average (D) None of the above

100. The flow within the boundary layer is—
(A) Only laminar
(B) Only turbulent
(C) Either laminar or turbulent
(D) None of the above

101. Load factor is equal to—
(A) $\frac{\text{Peak load in a certain period}}{\text{Average load during that period}}$
(B) $\frac{\text{Average load over a certain period}}{\text{Plant installed capacity}}$
(C) $\frac{\text{Average load over a certain period}}{\text{Maximum load occuring during the same period}}$
(D) $\frac{\text{Average plant capacity utilization}}{\text{Actual load or plant during that period}}$

102. Hydraulic jump is used for—
(A) Reducing the flow rate
(B) Reducing the energy of flow
(C) Increasing the flow rate
(D) Reducing the velocity of flow

103 Hydraulic jump occurs when—
(A) Flow is sub-critical
(B) Flow is supercritical
(C) Flow is supercritical and adequate downstream depth is available
(D) Adequate downstream depth is available

104. The column or slenderness ratio of buttress is given by—
(A) $\frac{\text{Height of buttress}}{\text{Spacing of buttress}}$
(B) $\frac{\text{Height of buttress}}{\text{Thickness of buttress}}$
(C) $\frac{\text{Height of buttress}}{\text{Width of buttress}}$
(D) $\frac{\text{Height of buttress}}{\text{Massiveness factor}}$

105. $\sqrt{\frac{\text{Inertia force}}{\text{Pressure force}}}$ is known as—
(A) Weber's number
(B) Mach number
(C) Euler's number
(D) Prandtl number

106. $\sqrt{\frac{\text{Inertia force}}{\text{Gravity force}}}$ is known as—
(A) Nusselt number
(B) Mach number
(C) Reynolds number
(D) Froude number

107. Best section for open channel flow is—
(A) Semi-circle
(B) Triangular
(C) Rectangular
(D) Trapezoidal

108. Which fluid is the heaviest ?
(A) Castor oil
(B) Air
(C) Carbon tetrachloride
(D) Glycerine

109 A rotameter should always be installed in—
(A) Inclined at 45° to vertical
(B) Vertical position
(C) Inclined at 30° to vertical
(D) Horizontal position

110. In a flow field, at the stagnation point—
(A) Total energy is zero
(B) Pressure is zero
(C) All the velocity head is converted into pressure head
(D) Pressure head is equal to velocity head

111 Notch is a device used for measuring—
(A) Velocity through a small channel
(B) Rate of flow through pipe
(C) Rate of flow through a small channel
(D) Velocity through a pipe

112. Submerged weight of a body is—
(A) Less than its weight in air
(B) Greater than its weight in air
(C) Greater than its weight in vacuum
(D) Equal to its weight in air

113. The flow between any two stream lines—
(A) Remains the same
(B) Is always zero
(C) Increase along its path
(D) Decreases along its path

114. Which two forces are most important in laminar flow between closely parallel plates ?
(A) Viscous and pressure
(B) Gravity and pressure
(C) Inertial and viscous
(D) Pressure and inertial

115. A draft tube converts—
(A) Kinetic energy into mechanical energy
(B) Potential head into pressure head
(C) Velocity head into pressure head
(D) Pressure energy into kinetic energy

## Answers

| | | | | |
|---|---|---|---|---|
| 1. (A) | 2. (D) | 3. (C) | 4. (D) | 5. (C) |
| 6. (A) | 7 (C) | 8. (B) | 9. (C) | 10. (A) |
| 11. (A) | 12. (D) | 13. (A) | 14. (A) | 15. (B) |
| 16. (C) | 17. (A) | 18. (B) | 19. (A) | 20. (A) |
| 21. (A) | 22. (A) | 23. (A) | 24. (B) | 25. (A) |
| 26. (D) | 27. (B) | 28. (D) | 29. (B) | 30 (C) |
| 31. (C) | 32 (C) | 33. (A) | 34 (B) | 35. (C) |
| 36. (A) | 37. (B) | 38 (A) | 39 (A) | 40. (C) |
| 41. (D) | 42. (A) | 43. (C) | 44. (D) | 45. (B) |
| 46 (C) | 47. (C) | 48 (D) | 49 (C) | 50. (C) |
| 51 (C) | 52. (D) | 53 (B) | 54 (A) | 55. (D) |
| 56. (C) | 57. (B) | 58 (A) | 59. (C) | 60. (C) |
| 61. (A) | 62. (B) | 63 (B) | 64. (B) | 65 (A) |
| 66. (A) | 67. (B) | 68 (C) | 69. (B) | 70. (B) |
| 71. (C) | 72. (B) | 73. (C) | 74 (B) | 75. (A) |
| 76. (C) | 77. (A) | 78 (D) | 79 (C) | 80. (C) |
| 81. (A) | 82. (C) | 83. (B) | 84 (A) | 85. (B) |
| 86. (C) | 87. (C) | 88. (B) | 89. (A) | 90. (A) |
| 91. (C) | 92. (C) | 93. (C) | 94. (C) | 95. (B) |
| 96. (B) | 97 (A) | 98. (B) | 99. (B) | 100. (C) |
| 101. (C) | 102. (B) | 103. (C) | 104. (B) | 105. (C) |
| 106. (D) | 107. (A) | 108. (C) | 109. (B) | 110 (C) |
| 111 (C) | 112. (A) | 113. (A) | 114. (A) | 115. (A) |

# 6 INTERNAL COMBUSTION ENGINE

## Heat Engine

Heat engine is a device which converts the heat energy possessed by the fuel (coal,oil or gas) into mechanical energy.

Heat engines may be classified into two main classes as follows :

(A) External combustion engines [Steam engine]

(B) Internal combustion engines [Petrol engine, diesel engine]

## External Combustion Engine

The engine in which the combustion of the fuel takes place outside the engine cylinder and the heat energy obtained from the combustion of the fuel is converted into mechanical energy inside the engine cylinder, *i.e.* steam engine

There are several disadvantages in steam engine like—

(a) They have low efficiency

(b) They require more space

(c) They require more time for starting

(d) They work on low pressure and temperature

## Internal Combustion Engine

The heat engine in which the combustion of the fuel takes place inside the engine cylinder and the heat energy obtained from the combustion of the fuel is converted into mechanical work. *i.e.*, petrol engine, diesel engine and gas engine

There are several advantages over steam engine as under :

(a) They have high efficiency.

(b) They require less space or they are compact.

(c) They require less time for starting

(d) They work on high pressure and temperature.

## Classification of Internal Combustion Engine

The I.C. engine can be classified on the basis of—

(A) Types of the fuel used
- (i) Petrol or gasolene engine
- (ii) Diesel engine
- (iii) Gas engine

(B) Number of Strokes per cycle of working
- (i) Four stroke cycle engine
- (ii) Two stroke cycle engine

(C) Types of ignition used for the combustion of the fuel
- (i) Spark ignition engine
- (ii) Compression ignition engine
- (iii) Hot spot ignition engine

(D) Cycle of operations
- (i) Otto cycle engine
- (ii) Diesel cycle engine
- (iii) Dual combustion cycle engine

(E) Speed of the engine
- (i) Slow speed engine
- (ii) Medium speed engine
- (iii) High speed engine

(F) Method of fuel supply
- (i) Carburettor engine
- (ii) Air injection engine
- (iii) Airless or solid injection engine

(G) Type of cooling system adopted
- (i) Air cooled engine
- (ii) Water cooled engine
- (iii) Evaporative cooling type engine

(H) Location of valves
  (i) Over head valve engine
  (ii) Side valve engine
(I) Arrangement of cylinder
  (i) Horizontal engine
  (ii) Vertical engine
  (iii) Inclined engine
  (iv) Radial engine
  (v) V-engine
  (vi) Opposed piston engine
  (vii) Opposed cylinder engine
(J) The number of working cylinders
  (i) Single cylinder engine
  (ii) Multicylinder engine
(K) The applications
  (i) Stationary engine
  (ii) Automotive engine
  (iii) Marine engine
  (iv) Air-craft engine
  (v) Locomotive engine
(L) Methods of Governing
  (i) Hit and miss governed engine
  (ii) Qualitatively governed engine
  (iii) Quantitavely governed engine
(M) Miscellaneous types
  (i) Free piston engine
  (ii) Wankel engine
  (iii) Gas turbine
  (iv) Sterling engine

## Application of I.C. Engines

The I.C. engines are generally used for—
(i) Road vehicles
(ii) Air crafts
(iii) Locomotives
(iv) Construction-in-civil engineering equipment such as bulldozer, scraper, power shovels
(v) Pumping sets
(vi) Cinemas
(vii) Hospitals
(viii) Several industrial applications

## Different Parts of I.C. Engines

(A) Parts common to both petrol and diesel engines
  (i) Cylinder
  (ii) Cylinder head
  (iii) Piston
  (iv) Piston rings
  (v) Gudgeon pin
  (vi) Connecting rod
  (vii) Crank shaft
  (viii) Crank
  (ix) Engine bearing
  (x) Crank case
  (xi) Fly wheel
  (xii) Governor
  (xiii) Valves and valve operating machines
(B) Parts of petrol engine
  (i) Spark plug
  (ii) Carburettor
  (iii) Fuel pump
(C) Parts of diesel engine
  (i) Fuel pump
  (ii) Injector

## Major Terms connected with I.C. Engine

(i) **Bore**—The inside diameter of the cylinder is called bore

(ii) **Stroke**—The linear distance along the cylindrical axis between two limiting positions is called stroke

(iii) **Top dead centre (T.D.C.)**—The top most position of the piston towards cover end side of the cylinder is called top dead centre.

(iv) **Bottom dead centre (B.D.C.)**—The lowest position of the piston towards the crank and side of the cylinder is called bottom dead centre

(v) **Clearance volume**—The volume contained in the cylinder above the top of the piston, when the piston is at top dead centre, is called the clearance volume

(vi) **Swept volume**—The volume swept through the piston in moving between top dead centre and bottom dead centre, is called swept volume or piston displacement.

(vii) **Compression ratio**– It is the ratio of total cylinder volume to clearance volume

(viii) **Piston speed**– The average speed of the piston is called piston speed.

## Comparison between two stroke and four stroke I.C. engines

| Two stroke I.C. engine | Four stroke I.C. engine |
|---|---|
| 1. Two stroke engine complete the cycle of operations in two strokes of the piston. | 1. In four stroke engine, the working cycle of operations is completed in four strokes of the piston. |
| 2. Two stroke I.C. engines are simple in design. | 2. Four stroke I.C. engines are complicated in design. |
| 3. Two stroke I.C. engines are less complicated in construction. | 3. Four stroke I.C. engines are more complicated in construction. |
| 4. Output of the two stroke I.C. engines is more. It is approximately 60 to 80% more than four stroke engines. | 4. Output of the four stroke I.C. engines is |
| 5 There is one working stroke and once fuel is burnt in each revolution of the crank shaft. | 5 There is one working stroke and once the fuel is burnt in two revolutions of the crank shaft |
| 6. In two stroke I.C. engines a lighter flywheel is used because there is a little problem of balancing | 6. In four stroke I.C engines there is no problem of balancing |
| 7 The two stroke I.C engines are less efficient. | 7. The four stroke I.C engines are more efficient. |
| 8 Two stroke I.C engines consume more lubricating oil. | 8. Four stroke I.C engines consume less lubricating oil. |
| 9 There is more wear and tear in two stroke I.C. engine | 9 There is less wear and tear in it. |
| 10. It is more noisy. | 10. It is less noisy. |
| 11 There is more fuel consumption. | 11. There is less fuel consumption |

## Comparison between petrol engine and diesel engine

| Petrol Engine | Diesel Engine |
|---|---|
| 1. Air petrol mixture is sucked in the engine | 1. Only air is sucked during suction stroke |
| 2 Spark plug is used | 2. Employs an injector |
| 3. Power is produced by spark ignition. | 3 Power is produced by compression ignition |
| 4. Thermal efficiency upto 25%. | 4. Thermal efficiency upto 40% |
| 5. Occupies less space. | 5 Occupies more space. |
| 6. More running cost. | 6. Less running cost. |
| 7. Light in weight. | 7 Heavy in weight. |
| 8. Fuel (Petrol) costlier. | 8 Fuel (Diesel) cheaper |
| 9. Petrol being volatile is dangerous. | 9. Diesel is non dangerous as it is non-volatile. |
| 10. Pre-ignition possible | 10 Pre-ignition not possible |
| 11. Works on Otto cycle | 11 Works on Diesel cycle |
| 12. Less dependable. | 12. More dependable. |
| 13. Used in car and motorcycles. | 13 Used in heavy duty vehicles like trucks, buses and heavy machinery |
| 14. Compression ratio is low *i.e* 7 : 1 to 10 1 | 14. Compression ratio is high 11 · 1 to 22 1 |
| 15. Maintaining cost is more | 15 Maintaining cost is less |

## Performance of I.C. Engine

The basic performance parameters are as below :

(i) Power and mechanical efficiency
(ii) Mean effective pressure and torque
(iii) Specific output
(iv) Volumetric efficiency
(v) Fuel-air ratio
(vi) Specific fuel consumption
(vii) Thermal efficiency and heat balance
(viii) Exhaust smoke and other emissions
(ix) Specific weight

### Indicated Power

$$\text{I.P.} = \frac{n\, P_{mi}\, LANK \times 10}{6}\ \text{KW}$$

Where $n$ = No. of cylinders

$P_{mi}$ = Indicated mean, effective pressure bar

L = Length of stroke, in metre

A = Area of piston in metre square

$$K = \frac{1}{2} \text{ for 4-stroke engine}$$

$$= 1 \text{ for 2-stroke engine}$$

### Brake Power

$$\text{B.P.} = \frac{2\pi N T}{60 \times 1000}\ \text{KW}$$

N = Speed in r.p.m

and T = Torque in N-m

## OBJECTIVE QUESTIONS

1. Which of the following is an S.I. engine?
   (A) Diesel engine (B) Petrol engine
   (C) Gas engine (D) None of the above
2. Which of the following is C.I. engine?
   (A) Diesel engine (B) Petrol engine
   (C) Gas engine (D) None of the above
3. In a four stroke cycle petrol engine, during suction stroke—
   (A) Only air is sucked in
   (B) Only petrol is sucked in
   (C) Mixture of petrol and air is sucked in
   (D) None of the above
4. In a four stroke cycle diesel engine, during suction stroke—
   (A) Only air is sucked in
   (B) Only fuel is sucked in
   (C) Mixture of fuel and air is sucked in
   (D) None of the above
5. Compression ratio of petrol engines is in the range of—
   (A) 2 to 3 (B) 7 to 10
   (C) 16 to 20 (D) 80 to 90
6. Compression ratio of diesel engines may have the range—
   (A) 8 to 10 (B) 10 to 15
   (C) 16 to 20 (D) 80 to 90
7. The thermal efficiency of good I.C. engine at the rated load is in the range of—
   (A) 80 to 90% (B) 60 to 70%
   (C) 30 to 35% (D) 10 to 20%
8. Carburettor is used for—
   (A) S.I. engine (B) Gas engine
   (C) C.I. engine (D) None of the above
9. Fuel injector is used in—
   (A) S.I. engine (B) Gas engine
   (C) C.I. engine (D) None of the above
10. Very high speed engines are generally—
    (A) Gas engines (B) S.I engines
    (C) C.I. engines (D) Steam engines
11. In S.I. engine, to develop high voltage for spark plug—
    (A) Battery is installed
    (B) Distributor is installed
    (C) Carburettor is installed
    (D) Ignition coil is installed
12. In S.I engine, to obtain required firing order—
    (A) Battery is installed
    (B) Distributor is installed
    (C) Carburettor is installed
    (D) Ignition coil is installed
13. For petrol engine, the method of governing employed is—
    (A) Quantity governing
    (B) Quality governing
    (C) Hit and miss governing
    (D) None of the above
14. For diesel engine, the method of governing employed is—
    (A) Quantity governing
    (B) Quality governing
    (C) Hit and miss governing
    (D) None of the above

15. Voltage developed to strike spark in the spark plug is in the range _
    (A) 6 to 12 volts
    (B) 1000 to 2000 volts
    (C) 20000 to 25000 volts
    (D) None of the above

16. In a 4-cylinder petrol engine the standard firing order is—
    (A) 1-2-3-4 (B) 1-4-3-2
    (C) 1-3-2-4 (D) 1-3-4-2

17. The torque developed by the engine is maximum—
    (A) At minimum speed of engine
    (B) At maximum speed of engine
    (C) At maximum volumetric efficiency speed of engine
    (D) At maximum power speed of engine

18. Iso octane content in a fuel for S.I. engine—
    (A) Retards auto-ignition
    (B) Accelerates auto-ignition
    (C) Does not affect auto-ignition
    (D) None of the above

19 Normal heptane content in a fuel for S.I engine—
    (A) Retards auto-ignition
    (B) Accelerates auto-ignition
    (C) Does not affect auto-ignition
    (D) None of the above

20 The knocking in S.I engine increases with—
    (A) Increase in inlet air temperature
    (B) Increase in compression ratio
    (C) Increase in cooling water temperature
    (D) All the above

21. Petrol commercially available in India for Indian passenger cars has octane number in the range—
    (A) 40 to 50 (B) 60 to 70
    (C) 80 to 85 (D) 95 to 100

22. Cetane number of the fuel used commercially for diesel engine in India is in the range—
    (A) 80 to 90 (B) 60 to 80
    (C) 60 to 70 (D) 40 to 45

23. The injection presence in diesel engine is of the order of –
    (A) 30–40 bar (B) 100–150 bar
    (C) 170–220 bar (D) 400–600 bar

24. The ignition temperature of diesel fuel is about—
    (A) 200°C (B) 400°C
    (C) 550°C (D) 700°C

25. In a petrol engine the delay period is of the order of—
    (A) 0·001 *s* (B) 0·002 *s*
    (C) 0·015 *s* (D) 0·06 *s*

26 . . is not the effect of detonation—
    (A) Loud and pulsating noise
    (B) High local stresses
    (C) High operating temperature
    (D) Loss in efficiency and power output

27. The ignition quality of a petrol engine fuel is expressed as—
    (A) Octane number (B) Cetane number
    (C) API gravity (D) SAE rating

28. The capacity of most of the mopeds in India is—
    (A) 50 cc (B) 150 cc
    (C) 200 cc (D) 250 cc

29 is used for the insulating body of a spark plug
    (A) Dolomite (B) Alumina
    (C) Glass (D) Silica

30. The compression ratio in diesel engine is ..... in comparison to expansion ratio—
    (A) Less (B) More
    (C) Same (D) Variable

31. In an automobile the magneto is basically—
    (A) d.c. generator (B) a.c. generator
    (C) Transformer (D) Capacitor

32 Scavenging is usually done to increase—
    (A) Power output
    (B) Fuel consumption
    (C) Thermal efficiency
    (D) Speed

33. For a petrol engine for vehicles the air fuel ratio for maximum power generation is of the order of –
(A) 8 . 1 (B) 12 : 1
(C) 18 : 1 (D) 20 : 1

34. In loop scavenging the top of the piston is—
(A) Convex shaped (B) Depressed
(C) Slanted (D) Contoured

35. The part load efficiency of a carburettor is—
(A) Constant (B) Maximum
(C) Optimum (D) Poor

36. . can work on very lean mixture.
(A) C.I. engine (B) S.I. engine
(C) 2-stroke engine (D) 4-stroke engine

37. Thermal efficiency of I.C. engine on weak mixture is—
(A) Lower (B) Higher
(C) Unaffected (D) Unpredictable

38. Cetane number is the measure of—
(A) Viscosity of fuel
(B) Ignition quality
(C) Calorific value of fuel
(D) None of the above

39 In a S.I. engine an ignition coil performs which of the following functions—
(A) Regulates battery voltage
(B) Avoids sparking
(C) Controls spark
(D) Supplies high voltage to the spark plug

40 The octane rating of the commercially available petrol in India is—
(A) 15–35 (B) 45–55
(C) 60–70 (D) 85–90

41. . lubrication technique is used for lubrication of the cylinder of a scooter engine.
(A) Petrol (B) Splash
(C) Gravity feed (D) Forced feed

42. In 4-stroke engine the camshaft rotates at . the crank shaft speed
(A) Half (B) Three-fourth
(C) Equal (D) Double

43. The minimum number of rings in a piston—
(A) 2 (B) 3
(C) 4 (D) 6

44. ..... process is not associated with diesel cycle
(A) Constant pressure
(B) Constant volume
(C) Adiabatic
(D) Isothermal

45 Hunting occurs due to which of the following ?
(A) Faulty governor
(B) Poor-control by the governor
(C) Over-control by the governor
(D) Bad engine design

46. Maximum torque is generated by an engine when—
(A) It runs at lowest speed
(B) It develops maximum power
(C) It consumes maximum fuel
(D) None of the above

47 With an increase of the number of cylinders in a multicylinder engine the power to weight ratio—
(A) Decreases
(B) Increases
(C) Remains unaffected
(D) None of the above

48 Lean air-fuel mixture is required for—
(A) Idling (B) Acceleration
(C) Starting (D) Cruising

49 ..... is not a part of petrol engine
(A) Air filter
(B) Induction coil
(C) Valve mechanism
(D) Fuel injector

50 .. of heat supplied in the form of fuel in a 4-stroke engine is carried away by exhaust gases
(A) 3–7% (B) 8–12%
(C) 20–35% (D) 45–55%

51. Petrol engines are adjusted to give minimum brake specific fuel consumption at—
(A) No load
(B) 20–30% of full load

(C) About 70% of full load
(D) Near full load

52. Crank shafts are generally—
(A) Die cast
(B) Sand cast
(C) Forged
(D) Turned from bar stock

53. ..... has maximum resistance to detonation.
(A) Alcohol (B) Benzene
(C) Toulene (D) Iso-octane

54. In isochronous governors the speed drop is—
(A) Zero (B) 5%
(C) 30% (D) 50%

55. The top ring nearest to the piston crown is known as—
(A) Compression ring
(B) Oil ring
(C) Scrapper ring
(D) Groove ring

56. A diesel engine as compared to petrol engine is—
(A) Less efficient (B) More efficient
(C) Equal efficient (D) None of the above

57. The level of oil in engine cylinder should be checked when the engine is—
(A) Running (B) Not running
(C) During starting (D) During cranking

58 Endurance for I.C. engine is conducted for—
(A) 200 hours (B) 300 hours
(C) 400 hours (D) 500 hours

59. Movement of air inside engine cylinder does not help in—
(A) Reducing noise
(B) Mixing of fuel with air
(C) Distribution of fuel
(D) Reducing after burning

60. An engine indicator is used to determine—
(A) Temperature
(B) m.e.p. and I.P
(C) Speed
(D) Volume of cylinder

61. The cam shaft of a 4-stroke I.C. engine running at 2000 r.p.m. will run at—
(A) 2000 r.p.m. (B) 1500 r.p.m.
(C) 1000 r.p.m. (D) 500 r.p.m

62 In a cycle the spark lasts for—
(A) 0·001 s (B) 0·01 s
(C) 0·1 s (D) 1 s

63. By which of the following is the air pressure produced in the crankcase method of scavenging ?
(A) Natural aspiration
(B) Movement of engine piston
(C) Supercharger
(D) None of the above

64. The piston of an I.C. engine completes two strokes in—
(A) 180° of crank rotation
(B) 360° of crank rotation
(C) 540° of crank rotation
(D) 720° of crank rotation

65. Displacement volume or swept volume is the volume displaced by the piston in—
(A) 2-strokes (B) 4-strokes
(C) 1-stroke (D) $\frac{1}{2}$-stroke

66. If the engine is running at 1600 r.p.m. the speed of cam shaft will be—
(A) 400 r.p.m. (B) 800 r.p.m
(C) 1600 r.p.m. (D) None of the above

67 Spark ignition engine works on—
(A) Carnot cycle
(B) Rankine cycle
(C) Constant pressure cycle
(D) Constant volume cycle

68. C.I. engine works on—
(A) Bell Coleman cycle
(B) Carnot cycle
(C) Constant pressure heat addition cycle
(D) Otto cycle

69. The term 'Bore' in I.C. engine is used for—
(A) Inside diameter of cylinder
(B) Diameter of piston
(C) Diameter of piston ring
(D) None of the above

70. Which of the following is related to S.I engine only ?
(A) Ignition coil (B) Flywheel
(C) Intel valve (D) Piston

71. In S.I. engine the method of governing used is –
(A) Quantitative governing
(B) Hit and miss governing
(C) Qualitative governing
(D) None of the above

72. The injection pressure in diesel engine is between—
(A) 0 — 10 kg/cm$^2$
(B) 10 — 50 kg/cm$^2$
(C) 100 — 150 kg/cm$^2$
(D) None of the above

73. Which one is not related to I.C. engine ?
(A) Gas turbine
(B) 4-stroke C.I. engine
(C) Steam turbine
(D) None of the above

74 Which is related to C.I. engine only ?
(A) Carburettor (B) Spark plug
(C) Atomiser (D) Distributor

75 In a low speed S.I. engine the inlet valve closes—
(A) 40° after B.D.C. (B) 30° before B.D.C
(C) 10° after B.D.C. (D) 10° before B.D.C

76 In a high speed S.I. engine, the exhaust valve starts to open—
(A) 10° after B.D.C. (B) 15° before B.D.C
(C) 55° after B.D.C. (D) 45° before B.D.C

77. The minimum number of compression rings provided on a piston are—
(A) 2 (B) 4
(C) 1 (D) 3

78. In four stroke four cylinder C.I. engine the number of spark plugs used are—
(A) Four (B) Eight
(C) One (D) Zero

79. In a four cylinder gasoline engine of a fiat car the number of carburettors fitted are—
(A) One (B) Two
(C) Three (D) Four

80. The main bearings of the engine support —
(A) Crank shaft (B) Cam shaft
(C) Both (D) None of the above

81 In a six cylinder C.I. engine the number of spark plugs required are—
(A) 6 (B) 1
(C) 12 (D) 0

82. Which of the following is related to S.I. engine ?
(A) Atomiser (B) D-slide valve
(C) Magneto (D) Fusible plug

83. The material used for the cylinder block is—
(A) Stainless steel (B) Grey cast iron
(C) Copper (D) Bronze

84. Connecting rod is made of—
(A) Cast iron
(B) Aluminium alloy
(C) Copper alloy
(D) Medium carbon steel

85. Piston rings are made of—
(A) Babi H (B) Bronze
(C) Cast iron (D) Steel alloys

86. Which is related to C.I engine ?
(A) Carburettor (B) Spark plug
(C) Injector (D) Distributor

87. The material of the exhaust valve is—
(A) Aluminium alloy
(B) Cast iron
(C) Silicon chrome steel
(D) None of the above

88. The flywheel is located on the—
(A) Rocker arm shaft
(B) Crank shaft
(C) Cam shaft
(D) All of the above

89. The face angle of the poppet tupe valve is generally –
(A) 15° (B) 20°
(C) 45° (D) 75°

90. The electrode of a spark plug is made of—
(A) Copper-alloy
(B) Alluminium alloy
(C) Nickel chromium alloy
(D) White metal

91. The I.H.P. of an individual cylinder of a multi-cylinder engine can be determined by –
(A) An indicator
(B) A morse test
(C) A rope brake dynamometer
(D) None of the above

92. An engine indicator is used to find out—
(A) b.h.p.
(B) f.h.p.
(C) Piston speed
(D) Mean effective pressure

93. The octane value of normal heptane is—
(A) 0 (B) 10
(C) 100 (D) 76

94. The capacity of the battery is given in terms of—
(A) Ampere-hour
(B) Voltage
(C) Weight of battery
(D) Volume of electrolyte

95 The battery generally used in a coil ignition system is of—
(A) 1·5 volts (B) 3 volts
(C) 12 volts (D) 24 volts

96 The temperature after ignition in I.C. engine is in the range of—
(A) 100° C to 150°C
(B) 150° C to 250°C
(C) 250° C to 500°C
(D) 2000° C to 2500°C

97. The lubricant used in I.C. engine are—
(A) Vegetable oils (B) Animal oils
(C) Graphite (D) Mineral oils

98. Viscosity meter is the instrument used for finding out the fluid's—
(A) Flash point (B) Viscosity
(C) Fire point (D) None of the above

99. The chemically correct air fuel ratio for a gasoline engine is—
(A) 5 · 1 (B) 10 : 1
(C) 15 12 : 1 (D) 20 : 1

100. The octane value of iso-octane is –
(A) 0 (B) 76
(C) 100 (D) 97

101 In a six cylinder engine, the power impulse occurs after '*x*' degrees of crank shaft rotation, where '*x*' is—
(A) 100 (B) 110
(C) 120 (D) 360

102 Firing order of a 6-cylinder in line engine is usually—
(A) 1–6–3–5–2–4 (B) 1–4–3–2–6–5
(C) 1–3–6–2–4–5 (D) 1–5–3–6–2–4

103. Can engines are usually—
(A) Single cylinder type
(B) Two-cylinder type
(C) Four-cylinder in line type
(D) Four cylinder V type

104. The fluctuation of engine speed during a cycle depends upon—
(A) Mass of flywheel
(B) Mass of crank shaft
(C) Speed of flywheel
(D) Power output

105. The materials used for cylinder block are—
(A) Cast iron and steel
(B) Cast iron and aluminium alloy
(C) Steel and aluminium alloy
(D) Brass and steel

106 On the compression stroke the rings are pressed against—
(A) Bottom of groove
(B) Top of groove
(C) Inner side of groove
(D) All of these

107 The uppermost ring on a piston is usually plated with—
(A) Cast iron (B) Chromium
(C) Steel (D) Aluminium

108. Compression rings are generally made of—
(A) High carbon steel
(B) Low carbon steel
(C) Cast iron
(D) Aluminium

109. In a six-cylinder car engine the angle between the successive crank throws is –
(A) 60° (B) 90°
(C) 110° (D) 120°

110. The number of main bearings in a 4-cylinder car engine is usually
(A) 2 (B) 3
(C) 4 (D) 6

111. Exhaust valve face angle is generally–
(A) 30° (B) 45°
(C) 60° (D) 75°

112. The engine valve are closed by—
(A) Crank shaft (B) Cam shaft
(C) Valve spring (D) Timing device

113. The throttle valve controls the supply of—
(A) Air only (B) Fuel only
(C) Air fuel mixture (D) None of these

114. The most accurate petrol injection system is the—
(A) Direct injection
(B) Port injection
(C) Manifold injection
(D) Throttle body injection

115. Brake thermal efficiency for S.I engines usually varies between—
(A) 25% and 30% (B) 30% and 60%
(C) 60% and 80% (D) More than 80%

## Answers

| | | | | |
|---|---|---|---|---|
| 1. (B) | 2. (A) | 3. (C) | 4 (A) | 5. (B) |
| 6 (C) | 7. (C) | 8 (A) | 9 (C) | 10. (B) |
| 11 (B) | 12 (B) | 13 (A) | 14 (B) | 15 (C) |
| 16. (D) | 17 (C) | 18 (A) | 19 (B) | 20. (D) |
| 21. (C) | 22. (D) | 23 (B) | 24. (B) | 25. (B) |
| 26. (D) | 27. (A) | 28 (A) | 29. (B) | 30. (B) |
| 31. (A) | 32 (A) | 33 (B) | 34 (D) | 35 (D) |
| 36. (A) | 37. (B) | 38. (B) | 39. (D) | 40. (D) |
| 41. (A) | 42. (A) | 43. (A) | 44. (D) | 45. (C) |
| 46. (A) | 47. (A) | 48. (D) | 49. (D) | 50. (C) |
| 51. (D) | 52. (C) | 53. (D) | 54. (A) | 55. (A) |
| 56 (B) | 57 (B) | 58 (D) | 59. (A) | 60 (B) |
| 61. (A) | 62. (C) | 63. (B) | 64. (B) | 65. (C) |
| 66. (B) | 67. (D) | 68. (C) | 69. (A) | 70. (A) |
| 71. (A) | 72 (C) | 73. (C) | 74. (C) | 75. (C) |
| 76. (C) | 77. (C) | 78. (D) | 79. (A) | 80. (A) |
| 81. (D) | 82. (C) | 83. (B) | 84. (D) | 85. (D) |
| 86 (C) | 87. (C) | 88 (B) | 89. (C) | 90. (C) |
| 91. (B) | 92. (D) | 93. (A) | 94. (A) | 95. (C) |
| 96. (D) | 97 (D) | 98 (B) | 99 (C) | 100 (C) |
| 101 (C) | 102. (D) | 103. (C) | 104. (A) | 105. (B) |
| 106 (A) | 107 (B) | 108 (C) | 109 (D) | 110 (B) |
| 111 (B) | 112 (C) | 113 (C) | 114 (B) | 115. (A) |

# 7 STEAM BOILERS, COMPRESSORS, ENGINES, NOZZLES, TURBINES, GAS TURBINES AND JET ENGINES

## Boiler

Simply a boiler may be defined as a closed vessel in which steam is produced from water by combustion of fuel

### The Steam Generated is employed for the following purposes

(i) For generating power in steam engines or steam purpose.

(ii) In the textile industries for sizing and bleaching etc. and many other industries like sugar mills, chemical industries

(iii) For heating the building in cold weather and for producing hot water for hot water supply

### The primary requirements of steam generators or boilers are

(i) The water must be contained safely

(ii) The steam must be safely delivered in desired condition

### Classification of Boilers

Boilers can be classified in a number of ways but the main bases for the classification of boilers can be as follows :

(i) Horizontal, vertical and inclined boilers

(ii) Stationary, portable and marine boilers

(iii) Water tube and fire tube boilers

(iv) Single tube and multi tube boilers

(v) Internally fired and externally fired boilers.

(vi) Naturally circulated and forced circulated boilers.

(vii) Source of heat (solid fuel, liquid and gaseous fuel, electrical and nuclear energy).

(viii) Low pressure, medium pressure and high pressure boilers.

### Boiler Mountings

These are the fittings, which are mounted on the boiler for its proper and safe functioning. Some important boiler mountings are—

(i) Water level indicator

(ii) Pressure gauge

(iii) Safety valves

(iv) Stop valve

(v) Blow off cock

(vi) Feed check valve

(vii) Fusible plug

### Boiler Accessories

These are the devices which are used as integral parts of a boiler, and help in running it efficiently Some important accessories are—

(i) Feed pump

(ii) Superheater

(iii) Economiser

(iv) Air preheater

### Essentials of a good Boiler

(i) A boiler should be light in weight, compact and should occupy a small space

(ii) A boiler should be capable of starting very quickly

(iii) A boiler should allow easy, cheap and quick maintenance

(iv) A boiler should be capable of meeting with the large variations in the load.

(v) In a boiler the velocity of water and fuel gases should be minimum after they have overcome the heavy frictional losses.

(vi) All the joints and fittings of a boiler should be easily accessible.

(vii) In a boiler, the flames produced by the combustion of the fuel should not impinge on its joints.

(viii) In a boiler, water scaling and soot etc should not collect in the tubes.

(ix) The tube of the boiler should be sufficiently strong to allow wear and corrosion.

(x) In the boiler the mud and other deposits should not collect on the heated surfaces.

(xi) A boiler should be capable of producing maximum amount of steam for minimum fuel consumption.

(xii) A boiler should have low initial cost.

(xiii) A boiler should have low cost of erection.

(xiv) A boiler should have high efficiency.

## Advantages of High Pressure Boiler

The following are the advantages of high pressure boiler :

(i) In high pressure boilers pumps are used to maintain forced circulation of water through the tubes of the boiler.

(ii) The heat of combustion is utilised more efficiently by the use of small diameter tubes in large number and in multiple circuits.

(iii) Pressurised combustion is used which increases rate of firing of fuel thus increasing the rate of heat release

(iv) Due to compactness less floor space is required.

(v) All the parts are uniformly heated, therefore the danger of overheating is reduced and thermal stress problem is simplified

(vi) All the parts are uniformly heated

(vii) The differential expansion is reduced due to uniform temperature and this reduces the possibility of gas and air leakages.

(viii) The steam can be raised quickly to meet the variable load requirements without the use of complicated control devices.

(ix) The efficiency of plant is increased upto 40 to 42% by using high pressure and high temperature steam.

(x) A very rapid start from cold is possible if external supply of power is available.

(xi) Use of high pressure and high temperature steam is economical

## Advantages of Velox Boiler

(i) The boiler is very compact and has greater flexibility

(ii) Very high combustion rates are possible

(iii) It can be quickly started

(iv) Low excess air is required as the pressurised air is used and the problem of draught is simplified.

## Advantages of Supercharged Boiler

(i) Owing to very high overall heat transfer coefficient the heat transfer surface required is hardly 20 to 25% of the heat transfer surface.

(ii) The part of the gas turbine output can be used to drive other auxiliaries.

(iii) Small heat storage capacity of the boiler plant gives better response to control.

(iv) Rapid start of the boiler is possible.

(v) Comparatively less number of operators are required.

**Steam Nozzles**—A steam nozzle may be defined as a passage of varying cross-section, through which heat energy of steam is converted to kinetic energy

**Hydraulic Turbines**—A hydraulic turbine is a prime mover that uses the energy of flowing water and converts it into mechanical energy in the form of rotation of the runner

## Classification of Hydraulic Turbine

(A) According to the action of the working liquid :
  (i) Impulse turbines
  (ii) Reaction turbines

(B) According to the direction of flow of the working fluid *i.e.* water in the runners :
  (i) Axial flow turbines
  (ii) Radial flow turbines
  (iii) Tangential flow turbines
  (iv) Mixed flow turbines

(C) According to the head of water available and the quality of water required for flow :
  (i) High head turbines
  (ii) Medium head turbines
  (iii) Low head turbines

(D) According to the name of the inventor of the turbine .
  (i) Pelton wheel or pelton turbine
  (ii) Francis turbine
  (iii) Kaplan turbine
(E) According to the specific speed of the turbine .
  (i) Single jet pelton wheels
  (ii) Francis turbine
  (iii) Propeller turbine
(F) According to the position of the shaft of the rotor :
  (i) Horizontal turbines
  (ii) Vertical turbines

**Steam Turbine**—A steam turbine is a prime mover in which the gradual change in the momentum of the steam are utilized to produce the rotary motion of the moving member. The desired momentum of steam is obtained by changing the direction of the jet of steam coming out at a high velocity from a nozzle.

## Classification of Steam Turbines

(A) With respect to the action of the steam :
  (i) Impulse turbines
  (ii) Reaction turbines
  (iii) Combination of impulse and reaction
(B) With respect to the number of rotors :
  (i) Single stage
  (ii) Multi stage
(C) With respect to the acting pressure of the steam :
  (i) High pressure steam turbines
  (ii) Medium pressure steam turbines
  (iii) Low pressure steam turbines
(D) With respect to the outlet pressure of steam from the turbine after expansion or action :
  (i) Condensing steam turbine
  (ii) Non-condensing steam turbine
(E) With respect to the direction of flow of steam :
  (i) Axial flow steam turbines
  (ii) Radial flow steam turbines
  (iii) Tangential flow steam turbines
  (iv) Mixed flow steam turbines
  (v) Helical flow steam turbines
  (vi) Re-entry flow type steam turbines
(F) With respect to the source of supply of steam
  (i) Extraction type steam turbines
  (ii) Accumulator type steam turbines

**Compressors**—The compressed air finds application in the following fields
  (i) Operating tools in factories
  (ii) Operating drills and hammers in road building
  (iii) Excavating
  (iv) Tunneling and mining
  (v) Starting diesel engines
  (vi) Operating brakes on buses, trucks and trains

**Gas Turbines**—The following are the major fields of application of gas turbines :
  (i) Aviation
  (ii) Power generation
  (iii) Oil and gas industry
  (iv) Marine propulsion

**The gas turbine have the following limitations**—
  (i) They are not self starting
  (ii) Low efficiency at part loads
  (iii) Non reversibility
  (iv) Higher rotor speeds
  (v) Overall efficiency of the plant low

**Classification**—The gas turbine are mainly divided into two groups :
  (i) Constant pressure combustion gas turbine;
    (a) Open cycle (b) Closed cycle
  (ii) Constant volume combustion gas turbine

## Merits and demerits of closed cycle turbine over open cycle turbine

(A) Merits of closed cycle :
  (i) Higher thermal efficiency
  (ii) Reduced size
  (iii) No contamination
  (iv) Improved heat transmission
  (v) Improved part load efficiency
  (vi) Lesser fluid friction
  (vii) No loss of working medium
  (viii) Greater output
  (ix) Inexpensive fuel
(B) Demerits of closed cycle :
  (i) Complexity
  (ii) Large amount of cooling water is required.

(iii) Dependent system

(iv) The weight of the system per H.P. developed is high comparatively, therefore not economical for moving vehicles

(v) Requires the use of a very large air heater

## Jet Propulsion

Jet propulsion systems are the system in which the work output of the gas turbine plant is used to produce high velocity jet of hot gases and this jet is used to propel the vehicles in which the systems are mounted

The various types of jet propulsion systems are as :

(i) Screw propeller

(ii) Turbo jet

(iii) Turbo-prop

(iv) Ram jet

## Advantage of Turbo Jet Engines

(i) Construction much simpler

(ii) Engine vibrations absent

(iii) Much higher speeds possible

(iv) Power supply is uninterrupted and smooth

(v) Weight to power ratios superior

(vi) Rate of climb higher

(vii) Requirement of major over-hauls less frequent

(viii) Radio interference much less

(ix) Maximum altitude ceiling

(x) Frontal area smaller

(xi) Fuel can be burnt over a large range of mixture strength

## Disadvantages of Turbo Jet Engines

(i) Less efficient

(ii) Life of the unit comparatively shorter

(iii) The turbo jet becomes rapidly inefficient below 550 km/h

(iv) More noisy

(v) Materials required are quite expensive

(vi) Requires longer strip since length of take off is too much

(vii) At take-off the thrust is low, this defect is overcome by boosting

# OBJECTIVE QUESTIONS

1. During the reversible adiabatic process, the entropy of steam—
   (A) Remains constant
   (B) Increases
   (C) Decrease
   (D) None of the above

2. With the increase in pressure the latent heat of vaporization—
   (A) Decreases
   (B) Increases
   (C) Remains constant
   (D) None of these

3. 1 Kg. of wet steam contains 0·15 Kg of water particles. Its dryness fraction is—
   (A) 15% (B) 100%
   (C) 85% (D) None of these

4. The throttling process on a mollier diagram is represented by a—
   (A) Horizontal line (B) Vertical line
   (C) Point (D) Curve

5. For a given law $P \times V^n$ = Constant, the value of n is given by the relation—
   (A) $1{\cdot}135 + 0{\cdot}1x$ (B) $1{\cdot}035 + 0{\cdot}1x$
   (C) $1.035 - 0.1x$ (D) $1{\cdot}135 - 0{\cdot}1x$

6. Which equation is true for the total heat of dry steam ?
   (A) $h/w + x\,L$
   (B) $h/w + L$
   (C) $h/w + L + C_p$
   (D) $x\,L + C_p\,(T_{sup} - T_{sat})$

7. The critical temperature of steam is—
   (A) 225·65 kg/cm$^2$ (B) 252·65 kg/cm$^2$
   (C) 347·15 kg/cm$^2$ (D) 374·15 kg/cm$^2$

8. Clapeyron's equation is used for evaluating—
   (A) Specific volume at any temperature and pressure
   (B) Dryness fraction of steam
   (C) Entropy of superheated steam
   (D) Total heat of saturation

9. A device used for generating steam for power generation is known as—
   (A) Turbine (B) Steam engine
   (C) Re-boiler (D) None of these
10. In a boiler if the furnace region is completely surrounded by water it is known as—
   (A) Externally fired boiler
   (B) Internally fired boiler
   (C) Water tube boiler
   (D) None of these
11. Central station steam generators are used for—
   (A) Electric power generator
   (B) Process heating in industries
   (C) Residential heating
   (D) Locomotives
12. The maximum pressure in a miniature boiler is—
   (A) 1 Kg/cm$^2$ (B) 10 Kg/cm$^2$
   (C) 25 Kg/cm$^2$ (D) 6·9 Kg/cm$^2$
13. The concentration of soluble salts and solid is reduced to the desired level by—
   (A) Priming
   (B) Blow-down
   (C) Gravity separation
   (D) None of these
14. The fusible plug is situated—
   (A) Near the manhole
   (B) Just below the water level
   (C) At the crown of the furnance
   (D) At the base of the boiler
15. Steam used in high pressure turbines must not contain impurities—
   (A) More than 10 p.p.m.
   (B) More than 0·3 p.p.m
   (C) More than 250 p.p.m.
   (D) More than 500 p.p.m.
16. The induced draft of the fan is used—
   (A) Before the furnance
   (B) At the base of the chimney
   (C) At the top of the chimney
   (D) In the manhole
17. The amount of K.cal. required to heat 1 kg. of water at 100°C to dry saturated steam at 100°C is—
   (A) 539 K.cal. (B) 100 K.cal
   (C) 53·9 K.cal. (D) None of these
18. In terms of equal evaporation on boiler HP is equal to—
   (A) 1·5563 Kg (B) 15·563 Kg
   (C) 34·5 Kg (D) 11 Kg
19. Smokeless or compact boiler is a—
   (A) Three pass boiler
   (B) Two pass boiler
   (C) Single pass boiler
   (D) None of these
20. In a super critical boiler the pressure range is—
   (A) 50 to 100 kg/cm$^2$
   (B) 100 to 150 kg/cm$^2$
   (C) 150 to 200 kg/cm$^2$
   (D) 225 to 250 kg/cm$^2$
21. Lancashire boiler is a—
   (A) Single pass boiler
   (B) Two pass boiler
   (C) Three pass boiler
   (D) Four pass boiler
22. A boiler known as a small steam jenny is used for—
   (A) Power generator
   (B) Heating purpose
   (C) Spray painting
   (D) None of these
23. If the steel boiler is properly installed and looked after its average life will be—
   (A) 5 years (B) 20 years
   (C) 50 years (D) 75 years
24. To produce one unit of electricity the approximate amount of coal burnt is—
   (A) 0·5 Kg (B) 1·6 Kg
   (C) 5 Kg (D) 10 Kg
25. In a babcock and wilcox boiler the tubes are inclined at
   (A) 0° (B) 90°
   (C) 15° (D) 45°

26. Economiser is used for –
    (A) Superheating the steam
    (B) Pre-heating of the feed water
    (C) Pre-heating the air
    (D) Condensing the exhaust steam of the engine

27. The Horse Power (H.P.) of boiler indicate—
    (A) The maximum pressure at which steam can be generated
    (B) The rate of generator of steam
    (C) The capacity of the shell
    (D) None of these

28. The function of fusible plug is—
    (A) To drain off the water of the shell
    (B) To prevent damage of boiler against over-heating
    (C) To blow off excess of steam
    (D) None of these

29. In tancashire boiler the number of fuel tubes are—
    (A) 2 (B) 3
    (C) 4 (D) 5

30 The function of superheater is to—
    (A) Pre-heat the feed water
    (B) Pre-heat the air
    (C) Increase the temperature of steam above saturation temperature
    (D) Increase the rate of combustion of fuel

31. The maximum working pressure of fire tube boiler is limited to—
    (A) 1·5 kg/cm$^2$ (B) 5 kg/cm$^2$
    (C) 20 kg/cm$^2$ (D) 100 kg/cm$^2$

32. In a steam engine can be a horizontal, vertical or inclined. This classification is according to the—
    (A) Expansion of steam
    (B) Position of cylinder
    (C) Field of application
    (D) Speed of the engine

33 A steam engine having a speed of 275 r.p.m is termed as a—
    (A) High speed engine
    (B) Low speed engine
    (C) Medium speed engine
    (D) None of these

34. In case of a condensing steam engine the exhaust from the steam engine is directly sent to the—
    (A) Atmosphere (B) Condenser
    (C) Hot well (D) Economiser

35 In a double acting steam engine the number of working strokes per revolution are—
    (A) 1 (B) 2
    (C) 3 (D) 4

36. The efficiency of the Rankine cycle is given by the relation—
    (A) $\frac{H_1 - H_2}{H_1 - Hw_2}$ (B) $\frac{H_1 + H_2}{H_1 - Hw_2}$
    (C) $\frac{H_1 + H_2}{H_1 + Hw_2}$ (D) $\frac{H_1 - H_2}{H_1 + Hw_2}$

37. Steam engine works on—
    (A) Constant volume cycle
    (B) Constant pressure cycle
    (C) Rankine cycle
    (D) Joule's cycle

38. Diagram factor is always—
    (A) More than one (B) Less than one
    (C) Equal to one (D) None of these

39. The approximate value of diagram factor is—
    (A) 0·2 (B) 0·5
    (C) 0·7 (D) 1·2

40 Willian's law is expressed mathematically as—
    (A) $w = a + \text{B.H.P} + b$
    (B) $w = a \times \text{I.H.P} + b$
    (C) $w = a \times \text{F.H.}b$
    (D) $w = a \times \text{I.H.P} - b$

41 In Rankine cycle expansion of steam assumed to be—
    (A) Adiabatic (B) Polytropic
    (C) Hyperbolic (D) Isothermal

42. The expansion of steam in hypothetical indicated diagram is assumed to be—
    (A) Isothermal (B) Polytropic
    (C) Hyperbolic (D) Adiabatic

43 The thermal efficiency of a steam engine is about—
    (A) 10% (B) 25%
    (C) 50% (D) 80%

44. When the steam is carried from boiler to the engine, the pressure of steam—
(A) Will increase
(B) Will decrease
(C) Will remain same
(D) None of these

45. The ratio of thermal efficiency to the standard efficiency is defined as—
(A) Overall efficiency
(B) Standard efficiency
(C) Relative efficiency
(D) Specific steam consumption

46. In a throttle governing the steam consumption per hour is directly proportional—
(A) B.H.P. of the engine
(B) I.H.P. of the engine
(C) F.H.P. of the engine
(D) None of these

47. The function of the governor in steam engine is to—
(A) Reverse its direction
(B) Control the speed
(C) Absorb the excess energy produced during a cycle
(D) Stop the engine

48 The thermal efficiency of steam engine is—
(A) More than steam turbine
(B) Less than steam turbine
(C) Equal to steam turbine
(D) Unpredictable

49 In uniflow steam engine the type of valve used for controlling the steam is—
(A) D Slide valve (B) Drop valve
(C) Corliss valve (D) None of these

50. In receiver type compound steam engine, the cranks of the two cylinder are placed—
(A) 90° to each other
(B) 180° to each other
(C) 360° to each other
(D) 45° to each other

51 In woolf type compound steam engine, the phase angle between two cranks is—
(A) 90° (B) 45°
(C) 180° (D) 120°

52. The work input to air compressor is minimum if the compression law followed is—
(A) $PV^{1.35} = C$
(B) Isothermal $PV = C$
(C) Isentropic $PV^{\gamma} = C$
(D) None of these

53. For reciprocating air compressor the law of compression desired is isothermal and that may be possible by—
(A) Very low speed
(B) Very high speed
(C) Any speed as speed does not affect the compression law
(D) None of these

54. Work input to the air compressor with 'n' as index of compression—
(A) Increases with increase in the value of 'n'
(B) Decreases with increase in the value of 'n'
(C) Remains same whatever the value of 'n'
(D) None of these

55 With increase in clearance volume, the ideal work of compressing 1kg of air—
(A) Increases (B) Decreases
(C) Remains same (D) None of these

56. Mechanical efficiency of reciprocating air compressor is expressed as—
(A) $\frac{B.P.}{I.P.}$ (B) $\frac{I.P}{B.P}$
(C) $\frac{F.P.}{B.P.}$ (D) $\frac{F.P}{I.P}$

57. In reciprocating air compressor the method of controlling the quantity of air delivered is done by—
(A) Throttle control
(B) Blow-off control
(C) Clearance control
(D) All of the above

58. The efficiency of vane type air compressor as compared to roots air compressor for the same pressure ratio is—
(A) More (B) Less
(C) Same (D) None of these

59. In centrifugal air compressor the pressure developed depends on –
(A) Impeller tip velocity
(B) Inlet-temperature
(C) Compression index
(D) All of the above

60. In air compresser installations where are separators generally used ?
(A) Before intercooler
(B) After intercooler
(C) Between aftercooler and receiver
(D) None of these

61. With an increase in compression ratio the volumetric efficiency of air compressor
(A) Decreases
(B) Increases
(C) Remains unchanged
(D) Unpredictable

62. Why is intercooling in multistage compressor done ?
(A) To minimise the work of compression
(B) To cool the air at delivery
(C) To cool the air during compression
(D) None of these

63 Why is an aftercooler used ?
(A) To remove impurities from air
(B) To reduce the volume of air
(C) To cool the air
(D) None of these

64. ..... type compressors are used for gas turbines
(A) Sliding vane (B) Centrifugal
(C) Axial flow (D) All of the above

65. Centrifugal blowers can supply .. volumes of air at ..... pressures.
(A) Large, low (B) Large, high
(C) Small, high (D) Small, low

66. is a non-positive displacement compressor.
(A) Reciprocating compressor
(B) Roots blower
(C) Axial flow compressor
(D) Vane blower

67. The performance of reciprocating compressor is compared on the basis of ..... efficiency.
(A) Volumetric (B) Mechanical
(C) Overall (D) Isothermal

68 Minimum work is required to compress the air when compression is—
(A) Polytropic (B) Adiabatic
(C) Isothermal (D) Any of the above

69. Which of the following is the most-efficient method of compressing air ?
(A) Adiabatically (B) Isothermally
(C) Isentropically (D) Polytropically

70. For which of the following Euler's equation is applicable—
(A) Axial compressor
(B) Centrifugal compressor
(C) Pumps
(D) All of the above

71 The ratio of indicated power to shaft power is known as ..... efficiency.
(A) Adiabatic (B) Mechanical
(C) Isothermal (D) Volumetric

72. In a compressor the clearance volume should be—
(A) As small as possible
(B) As large as possible
(C) About 25% of swept volume
(D) About 80% of swept volume

73. Rotary compressor is suited for .. quantity of air at ..... pressure.
(A) Large, low (B) Small, low
(C) Same, high (D) Large, high

74 At high altitude a compressor will draw—
(A) Less power (B) More power
(C) Same power (D) None of these

75 The volumetric efficiency of compressor with ..... in compression ratio.
(A) Decreases, increases
(B) Increases, increases
(C) Decreases, decreases
(D) Increases, decreases

76 .. is used to drive a rotary compressor.
(A) Engine (B) Electric motor
(C) Air motor (D) Either A or B

77. ..... is a positive displacement compressor
(A) Axial flow compressor
(B) Centrifugal flow compressor
(C) Roots blower
(D) None of these

78. Which of the following compressors is mostly used for supercharging I.C. engines ?
(A) Reciprocating compressor
(B) Axial flow compressor
(C) Roots blower
(D) Radial flow compressor

79. Reciprocating compressors are employed to compress air upto a pressure of ..... bar.
(A) 20 (B) 40
(C) 80 (D) More than 100

80. In a centrifugal compressor what is the usual value of power input factor ?
(A) 1·0 (B) 1·04
(C) 1·2 (D) 1·3

81 ..... is the ratio of isentropic work to Euler work, in a rotary bladed compressor.
(A) Degree of reaction
(B) Slip factor
(C) Work factor
(D) Pressure coefficient

82 An air compressor may be controlled by ..... control
(A) Clearance (B) Blow-off
(C) Throttle (D) Any of the above

83 With the decrease in the valve of index n the volumetric efficiency—
(A) Decreases
(B) Increases
(C) Remains unaffected
(D) None of these

84. A closed cycle gas turbine works on cycle.
(A) Rankine (B) Joule
(C) Atkinson (D) Brayton

85. In gas turbine high air fuel ratio—
(A) Reduces exhaust temperature
(B) Increases power output
(C) Improves thermal efficiency
(D) None of the above

86. A closed cycle gas turbine consists of a –
(A) Cooling chamber
(B) Heating chamber
(C) Compressor
(D) All of the above

87. For a gas turbine the air-fuel ratio is generally kept closer to —
(A) 10 : 1 (B) 25 : 1
(C) 45 . 1 (D) 60 : 1

88 ..... limits the maximum temperature in a gas turbine cycle.
(A) Turbine blade material
(B) Efficiency of combustion
(C) Quality of fuel
(D) None of these

89 . is used as a fuel in gas turbine.
(A) Liquid benzene (B) Powdered coal
(C) Producer gas (D) Any of the above

90. The ideal constant pressure gas turbine works on ..... cycle
(A) Brayton
(B) Joule
(C) Both (A) and (B)
(D) None of these

91 In gas turbines the pressure ratio is the ratio of—
(A) Exhaust pressure to inlet pressure
(B) Pressure across turbines
(C) Highest pressure to exhaust pressure
(D) None of these

92 .. is suitable for space travel
(A) Turbo propeller (B) Turbo jet
(C) Rocket (D) All of the above

93. Which of the following properties is most important for material used for gas turbine blade ?
(A) Bulk modulus (B) Fatigue
(C) Toughness (D) Creep

94. In a gas turbine the compression ratio is of the order of –
(A) 2 : 1 (B) 4 : 1
(C) 8 : 1 (D) 13 : 1

95. Compared to aircraft, the air velocity in a rocket is—
(A) Zero (B) Less
(C) Same (D) More

96. Compared to turbo jet, a turbo propeller gas ..... as the additional feature
(A) Diffuser (B) Intercooler
(C) Propeller (D) None of these

97. At a speed of about ..... the maximum propulsion efficiency of a turbo jet is attained.
(A) 400 Km/h (B) 1000 Km/h
(C) 1500 Km/h (D) 2400 Km/h

98. The overall efficiency of a rocket is maximum when aircraft velocity compared to jet velocity is—
(A) Half (B) Two-third
(C) One-fourth (D) Double

99 . . type of gas turbine is employed in aircraft units.
(A) Open (B) Closed
(C) Semi-closed (D) None of these

100. In practice, propulsion efficiency of the following order is obtained—
(A) 20% (B) 40%
(C) 60% (D) 75%

101. A condenser in a steam power plant—
(A) Increases expansion ratio of steam
(B) Reduces temperature of exhaust steam
(C) Reduces back pressure of steam
(D) All of these

102 A condenser where circulating water flows through tubes which are surrounded by steam is known as—
(A) Surface condenser
(B) Jet condenser
(C) Barometric condenser
(D) Evaporative condenser

103. The critical pressure ratio for initially dry saturated steam is—
(A) 0·546 (B) 0·582
(C) 0·528 (D) 0·577

104 The flow of steam is supersonic—
(A) At the throat of the nozzle
(B) At the entrance of the nozzle
(C) In the divergent portion of the nozzle
(D) In the convergent portion of the nozzle

105. The steam leaves the nozzle at a—
(A) High pressure and high velocity
(B) Low pressure and low velocity
(C) High pressure and low velocity
(D) Low pressure and high velocity

106 The difference of supersaturated temperature and saturation temperature at the pressure is known as—
(A) Degree of superheat
(B) Degree of undercooling
(C) Degree of supersaturation
(D) None of these

107. When the back pressure of a nozzle is below the designed value of pressure at exit of nozzle, the nozzle is said to be—
(A) Chocked (B) Under damping
(C) Over damping (D) None of these

108 For a Parson's reaction turbine, the degree of reaction is—
(A) 25% (B) 35%
(C) 45% (D) 50%

109 In a reaction turbine, when the degree of reaction is zero, then there is—
(A) No heat drop in the fixed blade
(B) No heat drop in the moving blade
(C) Maximum heat drop in the fixed blade
(D) Maximum heat drop in the moving blade

110. The maximum efficiency of a reaction turbine is—
(A) $\frac{2\sin^2\alpha}{1+\sin^2\alpha}$ (B) $\frac{1+\cos^2\alpha}{2\cos^2\alpha}$
(C) $\frac{1+\sin^2\alpha}{2\sin^2\alpha}$ (D) $\frac{2\cos^2\alpha}{1+\cos^2\alpha}$

111 The purpose of governing in steam turbine is to—
(A) Maintain the speed of the turbine
(B) Reduce the effective heat drop
(C) Reheat the steam and improve its quality
(D) Completely balance against end thrust

112. Curtis turbine is a—
(A) Pressure compounded turbine
(B) Pressure velocity compounded turbine
(C) Velocity compounded turbine
(D) None of these

113. The ratio of work done on the blades per kg of steam to the energy supplied to the blades is called -
(A) Mechanical efficiency
(B) Nozzle efficiency
(C) Diagram or blading efficiency
(D) Gross or stage efficiency

114. The compounding of turbines is done in order to—
(A) Improve efficiency
(B) Reduce exit losses
(C) Reduce speed of rotor
(D) All of these

115. De-Laval turbine is a—
(A) Impulse reaction turbine
(B) Multi-rotor impulse turbine
(C) Single rotor impulse turbine
(D) None of these

## Answers

| | | | | |
|---|---|---|---|---|
| 1. (A) | 2. (A) | 3. (C) | 4. (B) | 5 (B) |
| 6. (B) | 7. (A) | 8. (A) | 9. (D) | 10. (B) |
| 11. (A) | 12. (D) | 13. (B) | 14 (C) | 15. (B) |
| 16 (B) | 17. (A) | 18. (B) | 19 (A) | 20. (D) |
| 21. (C) | 22. (C) | 23. (B) | 24 (B) | 25. (C) |
| 26. (B) | 27. (B) | 28 (B) | 29 (A) | 30. (C) |
| 31 (C) | 32. (B) | 33. (A) | 34 (B) | 35. (B) |
| 36. (A) | 37. (C) | 38 (B) | 39. (C) | 40. (B) |
| 41. (C) | 42. (C) | 43. (B) | 44 (B) | 45 (C) |
| 46. (B) | 47. (B) | 48 (B) | 49 (D) | 50. (A) |
| 51. (C) | 52. (B) | 53. (A) | 54 (A) | 55. (C) |
| 56. (B) | 57. (D) | 58 (A) | 59 (D) | 60. (C) |
| 61. (A) | 62. (C) | 63. (C) | 64 (C) | 65 (A) |
| 66. (C) | 67. (D) | 68 (B) | 69 (B) | 70. (D) |
| 71. (B) | 72. (A) | 73. (A) | 74. (A) | 75 (D) |
| 76. (D) | 77 (C) | 78. (D) | 79. (D) | 80. (B) |
| 81. (D) | 82. (D) | 83. (A) | 84. (B) | 85. (A) |
| 86. (D) | 87. (D) | 88. (A) | 89. (D) | 90. (A) |
| 91. (C) | 92. (C) | 93. (D) | 94. (C) | 95. (A) |
| 96. (C) | 97. (D) | 98. (A) | 99. (A) | 100. (C) |
| 101. (D) | 102. (A) | 103. (D) | 104. (C) | 105. (D) |
| 106 (B) | 107. (B) | 108. (D) | 109. (B) | 110. (D) |
| 111 (A) | 112. (B) | 113 (C) | 114. (C) | 115. (C) |

# 8 HEAT TRANSFER, REFRIGERATION AND AIR-CONDITIONING

## Heat

There are three methods of transfer of Heat—

(i) **Conduction**—Conduction is the flow of heat through an unequally heated body from places of higher temperature to those of lower temperature without actual transference of particles constituting the body. Almost all solids are good conductors of heat.

(ii) **Convection**—It is the process by which heat is transferred from one place to another in a medium by the movement of particles of the medium. Convection occurs in fluids (liquid and gases).

(iii) **Radiation**—It is the process by which heat is transferred from one place to another without the agency of any intervening medium Heat from the sun comes on the earth by radiation

## Steady State

When the temperature of various points of the bar is changing the state is said as variable state After some time a state is reached when the temperature of each cross-section becomes steady This state is known as steady state

## Newton's Law of Cooling

According to this law, the rate of loss of heat of a body is directly proportional to the temperature difference between the body and the surroundings.

$$i.e., \quad \frac{dQ}{dt} = -k(T - T_0)$$

Where $T$ = Temperature of the body

and $T_0$ = Temperature of surrounding

This law is true for small temperature difference only.

**Black Body**—A black body is defined as a body which completely absorbs all the heat radiations falling on it without reflecting and transmitting any of it. When such a body is heated it emits radiations of all wavelengths depending upon the temperature of black body.

## Stefan's Law

According to Stefan's law, the total radiant energy E emitted per second from unit surface area of a black body is proportional to the fourth power of its absolute temperature T. Thus

$$E \propto T^4$$

$$E = \sigma T^4$$

Where $\sigma$ is known as Stefan's constant

## Emissive Power

The emissive power of a body at a given temperature and for particular wavelength is defined as the radiant energy emitted per second by unit surface area of the body per unit wavelength range

## Absorptive Power

The absorptive power of a body at a given temperature and for a particular wavelength is defined as the radiant energy absorbed per second by unit surface area of the body to the total energy falling per unit time on the same area.

## Kirchhoff's Law

This law states that the ratio of the emissive power to the absorptive power for radiation of a given wavelength is the same for all bodies at the same temperature and is equal to the emissive power of a perfectly black body at that temperature.

## Wien's Displacement Law

The wave-length corresponding to maximum energy is inversely proportional to the Kelvin temperature and is given by

$$\lambda_m \propto \frac{1}{T}$$

or, $\lambda_m T = \text{Constant}$

and Constant $= 2{\cdot}93 \times 10^{-3}$ mk

## Solar Constant

Solar constant is defined as the amount of energy received from the sun by the earth per minute per $cm^2$ of surface placed normally to the sun's rays at mean distance of the earth from the sun in the absence of atmosphere. The value of solar constant is $1{\cdot}937$ cal $cm^{-2}$ $min^{-1}$

## Refrigeration

'Refrigeration' is a science of the producing and maintaining temperature below that of the surrounding atmosphere.

Refrigeration is generally produced in one of the following three ways :

(i) By melting of a solid

(ii) By sublimation of a solid

(iii) By evaporation of a liquid

## Elements of Refrigeration System

All refrigeration systems must include atleast four basic units as given below :

(i) A low temperature thermal 'sink' to which heat will flow from the space to be cooled

(ii) Means of extracting energy from the sink, raising the temperature level of this energy and delivering it to a heat receiver

(iii) A receiver to which heat will be transferred from the high temperature high pressure refrigerant.

(iv) Means of reducing of pressure and temperature of the refrigerant as it returns from the receiver to the 'sink'.

## Refrigeration Systems

The various refrigeration systems may be enumerated as below :

(i) Ice refrigeration system

(ii) Air refrigeration system

(iii) Vapour compression refrigeration system

(iv) Vapour absorption refrigeration system

(v) Special refrigeration system —

- (a) Absorption refrigeration system
- (b) Cascade refrigeration system
- (c) Mixed refrigeration system
- (d) Vortex tube refrigeration system
- (e) Thermoelectric refrigeration system
- (f) Steam jet refrigeration system

## Aircraft Refrigerating Systems

The following air-refrigeration systems are used in aeroplanes

(i) Simple cooling system

(ii) Boot strap system

(iii) Regenerative cooling system

## These processes are completed in one cycle

(i) Compression

(ii) Condensation

(iii) Expansion

(iv) Vaporisation

## Desirable Properties of an Ideal Refrigeration

An ideal refrigerant should possess the following properties :

(A) Thermodynamic Properties—

- (i) Low boiling point
- (ii) Low freezing point
- (iii) Positive pressures (but not very high) in condenser and evaporator
- (iv) High saturation temperature
- (v) High latent heat of vaporisation

(B) Chemical Properties—

- (i) Non-toxicity
- (ii) Non-flammable and non-explosive
- (iii) Non-corrosiveness
- (iv) No effect on the quality of stored (food and other)
- (v) Non-irritating and odourless

(C) Physical Properties—

- (i) Low specific volume of vapour
- (ii) Low specific heat
- (iii) High thermal conductivity

(iv) Low viscosity
(v) High electrical insulation

(D) Other Properties—
(i) Ease of leakage location
(ii) Availability and low cost
(iii) Ease handling
(iv) High C.D.P
(v) Low pressure consumption per tonne of refrigeration
(vi) Low pressure ratio and pressure difference

## Refrigeration Components

Important refrigeration components are :

(A) Compressors—
(i) Reciprocating compressors
(ii) Centrifugal compressors
(iii) Rotary compressors
(iv) Screw compressors

(B) Condensers—
(i) Air cooled condensers
(ii) Water cooled condesers
(iii) Evaporative condensers

(C) Evaporators—
(i) Flooded type evaporators
(ii) Dry or direct expansion type evaporators on the basis of operating conditions :
(i) Bare-tube evaporator
(ii) Plate-surface evaporator
(iii) Fixed-tube evaporator

## Refrigeration Controls

There are six basic types of refrigerant flow controls—
(i) Hand expansion valve
(ii) Automatic expansion valve
(iii) Thermostatic expansion valve
(iv) Capillary tube
(v) Low-side float
(vi) High-side float

## Air-Conditioning

Air-conditioning is the simultaneous control of temperature, humidity, motion and purity of the atmosphere in a confined space.

## Human Comfort

Thermodynamically a human body feels comfortable when the heat produced by the metabolism of human body is equal to the sum of heat dissipated to the surroundings and the heat stored in the human body by raising the temperature of body tissues

## The following factors affect human comfort

(i) Temperature
(ii) Humidity
(iii) Air motion
(iv) Air purity

## The main parts of the equipment in the air-conditioning cycle are

(i) 
(ii) Supply ducts
(iii) Supply outlets
(iv) Space to be conditioned
(v) Return outlets
(vi) Return ducts
(vii) Filter
(viii) Heating chamber
(ix) Cooling coil

## Air-conditioning Systems

The air-conditioning systems are mainly classified as :

(i) Central systems
(ii) Zoned systems
(iii) Unitary systems
(iv) Unitary-central system

## Another method of classification of air-conditioning system is as follows

(i) Single air systems
(ii) Dual air systems
(iii) Primary air systems
(iv) Unit systems
(v) Panel systems

## Air Distribution

(A) Air handling system comprises—
(i) Air distribution system
(ii) Duct system
(iii) Fan

(B) Outlets may be classified as follows
  (i) Grille outlets
  (ii) Slot diffused outlets
  (iii) Ceiling diffuser outlets
  (iv) Perforated ceiling panels

(C) The supply ducts may be arranged in the following ways
  (i) Loop perimeter ducts system
  (ii) Downward system
  (iii) Upward

(D) Air distribution systems may be divided as—
  (i) Ejector system
  (ii) Downward system
  (iii) Upward system

(E) Three methods of sizing the ducts are
  (i) Velocity reduction method
  (ii) Equal friction method
  (iii) Static regain method

## OBJECTIVE QUESTIONS

1. The thermal conductivity is expressed as—
  (A) W/mk (B) $W/m^2k$
  (C) W/hmk (D) $W/h^2m^2k$

2. The overall coefficient of heat transfer is used in the problems of—
  (A) Radiation
  (B) Conduction
  (C) Convection
  (D) Conduction and convection

3 Thermal conductivity of non-metallic amorphous solid ..... with decrease in temperature.
  (A) Decreases
  (B) Increases
  (C) Remains constant
  (D) Unpredictable

4. Heat is transfer takes place as per ..... law of thermodynamics
  (A) Zeroth (B) First
  (C) Second (D) None of these

5. Heat closely related with .....
  (A) Energy (B) Entropy
  (C) Enthalpy (D) Temperature

6 .. has least value of conductivity.
  (A) Rubber (B) Air
  (C) Water (D) Glass

7 . has maximum value of thermal conductivity.
  (A) Lead (B) Copper
  (C) Steel (D) Aluminum

8. In which of the following cases molecular transmission of heat is smallest ?
  (A) Solids (B) Alloys
  (C) Gases (D) Liquids

9. Due to which of the following reasons cork is a good insulator ?
  (A) It is porous
  (B) Its density is low
  (C) It can be powdered
  (D) All of the above

10 is expected to have highest thermal conductivity.
  (A) Water (B) Melting ice
  (C) Solid ice (D) Steam

11. The temperature variation with time, in the lumped parameter model is—
  (A) Exponential (B) Sinusoidal
  (C) Cubic (D) Linear

12 number is relevant, is transient heat condition.
  (A) Reynolds (B) Fourier
  (C) Grashoff (D) Prandtl

13 number is generally associated with natural convection heat transfer.
  (A) Prandtl (B) Weaker
  (C) Nusselt (D) Grashoff

14. ..... is not the assumption in Fourier's equation of heat conduction
  (A) Constant temperature difference
  (B) Uniform area of cross-section
  (C) Steady heat flow
  (D) Homogeneous substance

15. A substance above critical temperature exists as -
    (A) Liquid (B) Solid
    (C) Gas (D) Wet vapour

16. Shape of an ideal thermometer should be
    (A) Cubical (B) Rectangular
    (C) Spherical (D) Cylindrical

17. Planck s law of radiation is application to ..... radiation.
    (A) Monochromatic (B) Thermal
    (C) Temperature (D) None of the above

18. The monochromatic emissivity of a white body at all wavelengths and temperatures is equal to—
    (A) Zero (B) 0·1 to 0·4
    (C) 0·6 (D) 1

19. A ..... body reflects entire radiation incident on it.
    (A) Trasparent (B) Black
    (C) Gray (D) White

20 ..... method is used to find the thermal conductivity of rubber.
    (A) Searle s
    (B) Lee s disc
    (C) Cylindrical shell
    (D) Laby and Hercus

21. ..... rays have least wavelength
    (A) Infrared (B) Ultraviolet
    (C) Radio (D) Cosmic

22. Dropwise condensation occurs on a surface
    (A) Oily (B) Smooth
    (C) Glazed (D) Coated

23 Least value of prandtl number can be expected in case of—
    (A) Water (B) Liquid metals
    (C) Salt solution (D) Sugar soluble

24 Agitated film evaporator is suitable for concentrating ..... liquids.
    (A) Viscous (B) Low temperature
    (C) Corrosive (D) Liquid level

25. The intensity of solar radiation on earth is $KW/m^2$
    (A) 1 (B) 3
    (C) 6 (D) 8

26 In ..... flow maximum heat transfer rate can be expected
    (A) Laminar (B) Turbulent
    (C) Counter current (D) None of these

27. The emissivity of a grey body is—
    (A) 0·5 (B) 1
    (C) Less than 1 (D) More than 1

28. For gases prandtl number is—
    (A) Near unity
    (B) Between 5 to 50
    (C) Between 60 to 100
    (D) Between 150 to 300

29 In ablation heat transfer method is used.
    (A) Nuclear war heat
    (B) Satellites
    (C) Rockets
    (D) None of these

30 number can be used for convective heat transfer
    (A) Mach (B) Froude
    (C) Nusselt (D) None of these

31. The ratio of thermal conductivity to that of water is nearly
    (A) 2 (B) 3
    (C) 4 (D) 6

32 In air preheater for boiler, heat is least transferred by—
    (A) Radiation (B) Conduction
    (C) Convection (D) Both

33. In which of the following cases non-isotropic conductivity is exhibited ?
    (A) Lead (B) Wood
    (C) Copper (D) Brass

34 is suitable for low temperature applications
    (A) Fused alumina bricks
    (B) Asbestos paper
    (C) Cork
    (D) Diatomacious earth

35. A dimensionless number which is the ratio of kinematic viscosity to thermal diffusivity is known as ..... number
    (A) Grashoff (B) Prandtl
    (C) Mach (D) Nusselt

36. Fog is formed due to—
    (A) Humidity
    (B) Low pressure
    (C) Temperature fall of atmosphere
    (D) All of the above

37. Which of the following is a very good insulator ?
    (A) Saw dust
    (B) A hard wood board
    (C) An asbestos sheet
    (D) A porcelain sheet

38. Thermal conductivity of liquids can be determined by—
    (A) Searl's method
    (B) Guarded plate method
    (C) Laby and Hercas method
    (D) None of the above

39 ..... is likely to have highest thermal conductivity.
    (A) Boiling water (B) Steam
    (C) Solid ice (D) Rain water

40. .. body transmits all the radiations falling on it
    (A) Transparent (B) Grey
    (C) Black (D) White

41. A radiation shield should have—
    (A) High emissivity
    (B) Low reflectivity
    (C) High reflectivity
    (D) None of these

42. ..... are generally diathermanous
    (A) Gases (B) Liquids
    (C) Solids (D) All of the above

43 The reflectance of a black body is—
    (A) Zero (B) Less than 1·0
    (C) 1·0 (D) Infinity

44 Grashoff number has significant role in heat transfer by .
    (A) Conduction
    (B) Radiation
    (C) Natural convection
    (D) Forced convection

45. Temperature of steam around 550°C can be measured by.....
    (A) Thermopile (B) Thermocouple
    (C) Thermometer (D) Radiation

46 Rating of a domestic refrigerator is of the order of—
    (A) 0·1 to 0·3 tonne (B) 2 tonnes
    (C) 5 tonnes (D) 10 tonnes

47. The C.O.P. of a heat pump for the same operating temperature limits, equals—
    (A) $(C.O.P)_{ref}$
    (B) $1 + (C.O.P)_{ref}$
    (C) $(C.O.P)_{ref} - 1$
    (D) $\frac{1}{(C.O.P)_{ref}}$

48. Air-refrigerator works on . . . cycle
    (A) Rankine
    (B) Bell-coleman
    (C) Reversed Carnot cycle
    (D) Both (B) and (C)

49. Bell-coleman cycle is a reversed ..... cycle.
    (A) Rankine (B) Otto
    (C) Joule (D) Carnot

50. The refrigerating capacity of 165 domestic refrigerator is approximately equal to—
    (A) 0·1 tonne (B) 1·15 tonnes
    (C) 5 tonnes (D) 8 tonnes

51 The Bell-coleman refrigeration cycle uses ..... as the working fluid
    (A) Air (B) $CO_2$
    (C) $H_2$ (D) None of these

52 Air-refrigeration cycle is used in—
    (A) Domestic refrigerators
    (B) Gas liquification
    (C) Commercial refrigerators
    (D) All of the above

53. cycle uses air as the refrigerant.
(A) Stirling (B) Ericsson
(C) Bell-coleman (D) Carnot

54. In a refrigeration cycle the heat is rejected by refrigerant at—
(A) Condenser (B) Evaporator
(C) Compressor (D) Expansion value

55. In a refrigeration cycle the flow of refrigerant is controlled by—
(A) Compressor
(B) Evaporator
(C) Expansion value
(D) Condenser

56. Which part of the vapour compression refrigeration cycle, produces the refrigeration effect ?
(A) Compressor (B) Condenser
(C) Evaporator (D) None of these

57. In the vapour compression refrigeration cycle, the refrigerant is generally in the form of fairly wet vapour at entry to—
(A) Compressor
(B) Condenser
(C) Expansion valve
(D) Evaporator

58 In a refrigeration cycle, the superheating C.O.P
(A) Decreases
(B) Does not change
(C) Increases
(D) None of these

59. In a refrigeration cycle oil separator is installed between—
(A) Condenser and expansion valve
(B) Compressor and condenser
(C) Condenser and evaporator
(D) None of these

60. In a small refregerator a capillary tube is used to serve the purpose of—
(A) Evaporator (B) Thermostat
(C) Condenser (D) Expansion valve

61. A device designed to remove moisture from a refrigerant is called –
(A) Dehumidifier
(B) Solenoid
(C) Expansion valve
(D) Drier

62. is usually the costliest item in a refrigeration system.
(A) Compressor
(B) Condenser
(C) Expansion valve
(D) Evaporator

63. The vapour pressure of refrigerant should be ..... atmospheric pressure.
(A) Lower than (B) Equal to
(C) Higher than (D) None of these

64. At the back of domestic refrigerator, the bank of tubes are—
(A) Evaporator tubes
(B) Condenser tubes
(C) Refrigerant cooling tubes
(D) Capillary tubes

65. Which refrigerant is used in a vapour absorption refrigerator ?
(A) Freon (B) Sulphur dioxide
(C) Water (D) Acqua-ammonia

66. In a vapour compression system the temperature of ammonia after compression is in the range—
(A) 15 to 25°C (B) 25 to 50°C
(C) 50 to 70°C (D) 70 to 110°C

67 Freon group of refrigerants are—
(A) Toxic
(B) Inflammable
(C) Nontoxic and inflammable
(D) Nontoxic and non-inflammable

68. Short horizontal lines on pressure-enthalpy chart show constant ..... lines
(A) Entropy (B) Pressure
(C) Temperature (D) Total heat

69 .. has the minimum freezing point.
(A) Freon-22 (B) Freon-12
(C) Carbon-dioxide (D) Ammonia

70. A refrigerant with highest critical pressure is.
(A) Carbon-dioxide
(B) Ammonia
(C) Freon-11
(D) Freon-22

71. . is the refrigerant widely used in domestic refrigerators.
(A) Carbon dioxide (B) Air
(C) Freon-12 (D) Ammonia

72. .. is the refrigerant commonly used in commercial ice plants.
(A) Carbon dioxide
(B) Air
(C) Ammonia
(D) Freon-12

73. The refrigerant used in steam jet refrigeration is—
(A) Brine (B) Water
(C) Ammonia (D) Freon-12

74 Which of the following refrigerants has the lowest boiling points ?
(A) Freon-12
(B) Carbon dioxide
(C) Ammonia
(D) Sulpher dioxide

75 The brine is an aqeous solution of in water
(A) Magnesium sulphate
(B) Sodium chloride
(C) Calcium carbonate
(D) None of these

76. The C.O.P. of a domestic refrigerator in comparison to domestic air-conditioner will be—
(A) Less (B) Same
(C) More (D) None

77. An electrolux refrigerator works on system.
(A) Vortex tube
(B) Absorption refrigeration
(C) Vapour compression
(D) None of these

78. In vapour absorption system lithium bromide is used as –
(A) Lubricant
(B) Cooling substance
(C) Absorbent
(D) Refrigerant

79. . is the least used refrigerant these days.
(A) Freon-12 (B) Sulpher dioxide
(C) Carbon dioxide (D) Ammonia

80. The refrigerant 717 is—
(A) Sulphur dioxide
(B) Ammonia
(C) Methyl chloride
(D) None of these

81 In ..... brine is always used as a secondary refrigerant.
(A) Milk chilling plant
(B) Ice plant
(C) Cold storage
(D) None of these

82 is not a desirable property of good insulating material
(A) Low initial cost
(B) Light weight
(C) Odourless
(D) High heat conductivity

83. In an unsaturated air the state of a vapour is—
(A) Wet (B) Superheated
(C) Saturated (D) Unsaturated

84 During sensible heating of moist air, enthalpy—
(A) Increases
(B) Decreases
(C) Remains constant
(D) None of these

85. During sensible cooling, wet bulb temperature –
(A) Decreases
(B) Increases
(C) Remains constant
(D) None of these

86. An air washer can work as a –
(A) Filter only
(B) Humidifier only
(C) Dehumidifier only
(D) All of the above

87. The relative humidity during sensible heating—
(A) Can increase or decrease
(B) Increases
(C) Decreases
(D) Remains constant

88. The vapour pressure, during sensible heating of moist air—
(A) Increases
(B) Decreases
(C) Remains constant
(D) None of these

89. The relative humidity, during heating and humidification—
(A) Increases
(B) Decreases
(C) May increase or decrease
(D) Remains constant

90 The relative humidity during cooling and dehumidification of moist air—
(A) Increases
(B) Decreases
(C) Can increase or decrease
(D) Remains constant

91. The wet bulb temperature is a measure of ..... humidity.
(A) Relative (B) Absolute
(C) Specific (D) None of these

92. The dry bulb temperature during heating and dehumidification
(A) Decreases
(B) Increases
(C) Remains constant
(D) None of these

93 The dehumidification process, on the psychrometric chart is shown by—
(A) Curved line (B) Vertical line
(C) Horizontal line (D) Inclined line

94. As warm air cools, its relative humidity . ..
(A) Decreases
(B) Increases
(C) Remains unchanged
(D) Unpredictable

95 During dehumidification process of removing moisture dry bulb temperature—
(A) Decreases
(B) Increases
(C) Remains constant
(D) Unpredictable

96 The wet bulb temperature, at 100 per cent relative humidity is ..... dew point
(A) Less than (B) Same as
(C) More than (D) None of these

97. In spray humidification process, the dry bulb temperature—
(A) Decreases
(B) Remains same
(C) Increases
(D) None of these

98. The wet bulb temperature during evaporative cooling process—
(A) Decreases
(B) Remains constant
(C) Increases
(D) Unpredictable

99. The wet bulb temperature during sensible cooling process—
(A) Decreases (B) Remains same
(C) Increases (D) Unpredictable

100. is a functional or decorative covering for an outlet or intake
(A) Register (B) Grille
(C) Diffuser (D) None of these

101 The thermal conductivity of solid metals..... with rise in temperature—
(A) Increases
(B) Decreases
(C) Remains same
(D) None of these

102. The process of heat transfer from one particle of the body to another is called conduction, when the particles of the body—
(A) Do not move actually
(B) Move actually
(C) Affect the intervening medium
(D) Does not affect the intervening medium

103. For summer air conditioning the relative humidity should not be less than—
(A) 40% (B) 60%
(C) 70% (D) 95%

104. For winter air conditioning the relative humidity should not be more than—
(A) 30% (B) 40%
(C) 75% (D) 90%

105. The conditioned air supplied to the room have the capacity to take up—
(A) Room sensible heat load only
(B) Room latent heat load only
(C) Both room sensible heat and latent heat loads
(D) None of these

106. The difference between dry bulb temperature and wet bulb temperature, is called—
(A) Dew point depression
(B) Dry bulb depression
(C) Degree of saturation
(D) Wet bulb depression

107 The process generally used in winter air conditioning to warm and humidify the air, is called—
(A) Humidification
(B) Heating and humidification
(C) Cooling and dehumidification
(D) Dehumidification

108. A mixture of dry air and water vapour, when the air has diffused the maximum amount of water vapour into it, is called—
(A) Dry air
(B) Saturated air
(C) Specific humidity
(D) Moist air

109 The temperature of air recorded by a thermometer, when it is not affected by the moisture present in it, is called –
(A) Dry bulb temperature
(B) Dew point temperature
(C) Wet bulb temperature
(D) None of these

110. In a vapour compression system, the condition of refrigerant before entering the compressor is—
(A) Wet vapour
(B) Saturated liquid
(C) Dry saturated liquid
(D) Superheated vapour

111 In ammonia hydrogen refrigerator—
(A) Ammonia is absorbed in winter
(B) Ammonia evaporates in hydrogen
(C) Hydrogen evaporates in ammonia
(D) Ammonia is absorbed in hydrogen

112. The boiling point of ammonia is—
(A) – 12·5°C (B) – 25·5°C
(C) – 33·3°C (D) – 75·5°C

113 Which of the following refrigerant is highly toxic and flammable ?
(A) Carbon dioxide (B) Freon-12
(C) Ammonia (D) Sulphur dioxide

114. The sub-cooling in a refrigeration cycle—
(A) Increases C.O.P
(B) Decreases C.O.P
(C) Does not alter C.O.P
(D) None of these

115. The highest temperature during the cycle, in a vapour compression system, occurs after—
(A) Condensation (B) Expansion
(C) Evaporation (D) Compression

## Answers

| | | | | |
|---|---|---|---|---|
| 1 (A) | 2 (D) | 3. (A) | 4 (C) | 5. (D) |
| 6 (B) | 7. (B) | 8. (D) | 9. (C) | 10. (C) |
| 11 (A) | 12 (B) | 13 (D) | 14. (B) | 15. (C) |
| 16 (C) | 17. (A) | 18 (A) | 19. (D) | 20. (B) |
| 21 (D) | 22 (A) | 23. (C) | 24. (A) | 25. (A) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26. (B) | 27. (C) | 28. (A) | 29 (B) | 30 (C) | 71 (C) | 72 (C) | 73. (B) | 74. (B) | 75. (B) |
| 31. (C) | 32. (A) | 33 (B) | 34. (D) | 35. (A) | 76. (A) | 77. (B) | 78 (C) | 79 (C) | 80. (B) |
| 36. (C) | 37. (A) | 38 (B) | 39 (C) | 40. (A) | 81 (B) | 82. (D) | 83. (B) | 84 (A) | 85. (A) |
| 41. (C) | 42. (A) | 43. (A) | 44. (C) | 45 (B) | 86 (D) | 87. (C) | 88 (C) | 89 (A) | 90. (C) |
| 46. (A) | 47. (B) | 48. (D) | 49 (C) | 50. (A) | 91 (B) | 92. (B) | 93 (B) | 94 (B) | 95. (C) |
| 51. (A) | 52. (B) | 53. (C) | 54. (A) | 55. (C) | 96 (B) | 97. (A) | 98 (B) | 99 (A) | 100. (B) |
| 56. (C) | 57. (D) | 58. (A) | 59 (B) | 60. (D) | 101 (B) | 102. (A) | 103. (B) | 104. (B) | 105. (C) |
| 61. (D) | 62. (A) | 63 (C) | 64 (B) | 65. (D) | 106 (D) | 107. (B) | 108 (B) | 109 (A) | 110. (D) |
| 66. (D) | 67. (D) | 68 (B) | 69. (A) | 70. (B) | 111 (B) | 112. (C) | 113 (C) | 114 (A) | 115. (D) |

# 9 THEORY OF MACHINES AND MACHINE DESIGN

## Kinematic Link or Element

Each part of a machine which moves relative to some other part, is known as kinematic link or element. A link has two characteristics :

(i) It should have relative motion.

(ii) It must be a resistant body.

The links are of the following type :

(i) Rigid link

(ii) Flexible link

(iii) Fluid link

## Kinematic Pair

The two links or elements of a machine when in contact with each other are said to form a pair The kinematic pairs may be classified as follows :

(A) According to the type of relative motion between the elements—

(i) Sliding pair

(ii) Turning pair

(iii) Rolling pair

(iv) Screw pair

(v) Spherical pair

(B) According to the type of contact between the elements—

(i) Lower pair

(ii) Higher pair

(C) According to the type of closure—

(i) Self closed pair

(ii) Force-closed pair

## Transmission of Power

The technique of transferring mechanical power from one shaft to another with the help of various means is called transmission of power.

## Modes of Transmission of Power

(A) Belts (Flat belts and V belts) and ropes

(B) Chains

(C) Gears

(D) Clutches

**Belts and ropes** are used when the distance between the shaft-centres is large.

**Chains** are used when the distance between the shaft centres is large and no slip is required.

**Gears** are employed when the shaft distance is adequately less.

**Clutches** are used where the shaft distance is adequately less.

**Clutches** are used where the shafts are co-axial

## Classification of Belts

The general classification of the belts used for transmission of power depends upon : (1) The cross-section of the belt. (2) The material used in the construction of the belt.

(1) Depending upon the cross-section, the belts can have the following classification—

(i) Flat belts

(ii) V-belts

(iii) Circular belts

(2) Depending upon the material used for the construction of the belt.

(i) Leather belts

(ii) Cotton belts

(iii) Rubber belts

(iv) Metallic belts

(v) Steels belts

## Belt Drive

A belt's drive consists of the driving and driven pulleys and the belt which is mounted on the pulleys with a certain amount of tension and transmits peripheral force by friction Belt drives may be—

(i) Open belt drive

(ii) Crossed belt drive

## Applications of Belt Drives

The main applications of belt drives are :

(i) To transmit power from low or medium capacity electric motors to operative machines.

(ii) To transmit power from small prime moves (Internal combustion engines) to electric generators, agricultural and other machinery.

## Advantages of Belt drives

(i) They can transmit motion over medium distances.

(ii) They give smooth operation (they cushion shocks and are silent).

(iii) They can operate at high speeds of rotation.

(iv) Their cost is relatively low.

## Disadvantages

(i) Their considerable overall size, usually several times larger than toothed gearing.

(ii) The inevitability of some elastic slipping of the belt.

(iii) The necessity for belt tensioning devices

(iv) The necessity to keep oil from getting on the belt

(v) The relatively short service life in high speed drives.

## Belts are available

(i) With a narrow rectangular cross-section —Flat belts

(ii) With a trapezoidal cross-section —V-belts

(iii) Round cross-section — Round - belts Chiefly used in machinery are flat and V-belts

## Advantages of V-belt are as follows

(1) No possibility of belt coming out of grooves.

(2) Particularly suited for small centre distances requiring no idler.

(3) V-belts may be used for speed ratio as high as 10 : 1 and belt speeds upto 2100 m/min.

(4) Wedging action permits a smaller arc of contact.

(5) The gripping action results in lower belt tension.

(6) Power output can be increased by use of multiple belts.

(7) In case of multiple-belt drive, if one belt fails, the machine does not come to a stop

(8) As V-belts are made endless the splicing problem is eliminated.

(9) V-belts after a more positive drive because of reduced slippage.

(10) As these can be used over small pulleys, large reductions in speed are possible in a single drive.

(11) V-belt drive may be inclined at any operating angle, slack side top or bottom.

(12) Drives are quiet at high speeds.

(13) The drive is capable of absorbing high shock.

(14) Standardisation of V-belts results in better initial installation and replacement

## Velocity Ratio

The velocity ratio between the two shafts depends upon the diameters of the respective pulleys One of the pulleys may be called a driver and the other a follower

In an open drive both the pulleys rotate in the same direction, whereas in a crossed belt-drive they rotate in opposite direction.

$$\text{Velocity ratio} = \frac{N_2}{N_1} = \left(\frac{100 - S}{99}\right)\left(\frac{d_1 + t}{d_2 + t}\right)$$

Where $d_1$ = $(2r_1)$ = diameter of the driver pulley

$d_2$ = $(2r_2)$ = diameter of the driven pulley or follower

$N_1$ = Revolutions per minute (r.p.m.) of the driver

$N_2$ = Revolutions per minute (r.p.m.) of the driven

S = Total % age percentage slip between driver and the follower

## Gear Trains

A gear is a wheel provided with teeth which meshes with the teeth on another wheel, or on to a rack so as to give positive transmission of motion from one component to another

## Pitch Circle

It is an imaginary circle which would transmit the same motion as the actual gear by pure rolling action.

**Addendum Circle**—A circle concentric with the pitch circle and bounding the outer ends of the teeth is called an addendum circle

**Addendum**—It is the radial distance between the pitch circle and addendum circle.

**Dedendum (or roof) Circle**—It is a circle concentric with the pitch circle and bounding the bottom of the tooth

**Dedendum**—It is the radial distance between the pitch circle and the dedendum circle.

**Clearance**—The difference between the dedendum and addendum is called as clearance.

**Working Depth**—It is the sum of the addenda of the two mating gears.

**Circular Thickness**—The length of arc between the sides of a gear tooth measured on the pitch circle is known as circular thickness.

**Tooth Space**—It is width of the recess between two adjacent teeth measured along pitch circle

**Back Lash**—It is the difference between the tooth space and the tooth thickness.

**Face**—It is the acting or working surface of the addendum.

**Flank**—The working face of the dedendum is called the flank.

**Top land**—It is the surface of the top of the tooth.

**Bottom Land**—It is the surface of the bottom of the tooth space.

**Whole depth**—It is the total depth of the tooth space, equal to addendum plus dedendum, also it is equal to the working depth plus clearance

**Tooth Fillet**—It is the radius which connects the root circle to the tooth profile.

**Circular Pitch**—The distance measured along the pitch circle from a point on one tooth to the corresponding point on an adjacent tooth is called circular pitch.

**Pitch Diameter**—It is the diameter of a pitch circle. It is usually represented by $d_p$ or $d_t$ for pinion and gear respectively.

**Diametral Pitch**—Number of teeth on a wheel per unit of its pitch diameter is called the diametral pitch

**Module**—It is the reverse of the diametral pitch. Ratio between the pitch diameter and the number of teeth is known as module

**Types of Gears**—The different types of gears are :

(i) Spur gear
(ii) Helical gear
(iii) Bevel gear
(iv) Worm gear
(v) Rack and pinion

**Types of Gear Trains**—The combination of gear wheels by means of which motion is transmitted from one shaft to another shaft is called a gear train.

The gear trains are of the following types—

1. Simple gear train
2. Compound gear train
3. Epicycle gear train

## Vibrations

**Types of Vibrations**—

(1) Free or natural vibrations
(2) Damped vibrations
(3) Forced vibrations

(1) **In Free or Natural Vibration**, after the initial displacement no external forces, act and motion is maintained by the internal elastic forces.

(2) **In Damped Vibration** the energy possessed by the system is gradually dissipated in overcoming internal and external resistances to the motion and the body finally comes to rest.

(3) **In Forced Vibration** a periodic disturbing force is applied to the body and the vibration has the same frequency as the applied force.

**Fatigue Stress Concentration Factor**—Fatigue stress concentration factor is defined as the ratio of endurance limit without stress concentration to endurance limit with stress concentration.

## Riveted Joints

**Types of Riveted Joints**—The riveted joints can mainly be classified in the following two ways –

1. Lap joints
2. Butt joints

**Shafts** – Standard sizes of transmission shafts. The standard sizes of transmission shafts are

(i) 25 mm to 60 mm with 5 mm steps
(ii) 60 mm to 110 mm with 10 mm steps
(iii) 110 mm to 140 mm with 15 mm steps
(iv) 140 mm to 500 mm with 20 mm steps

## Maximum Permissible Working Stresses for Transmission shafts

(A) For design purpose : The maximum permissible working stresses in tension or compression may be taken as follows—
  (i) For shafts without allowance for keyways .....112 $MN/m^2$
  (ii) For shafts with allowance for keyways ..... 84 $MN/m^2$

(B) The maximum permissible shear stresses may be taken as follows :
  (i) For shafts without allowance for keyways ..... 56 $MN/m^2$
  (ii) For shafts with allowance for keyways ..... 42 $MN/m^2$

**Sliding Bearings**—Depending upon the thickness of layer of the lubricant between the bearing and journal, the sliding bearing may be classified as follows .

(A) **Thin Film Bearings**—These are also boundary lubricated bearings. In such bearing, although lubricant is present, the working surfaces partially contact each other at least part of the time.

(B) **Thick Film Bearings**—These are also called hydrodynamic bearings. In these bearings the working surfaces are completely separated from each other by the lubricant.

(C) **Zero Film Bearings**—The bearings which operate without any lubricant present are called zero film bearings.

(D) **Hydrostatic or Externally Pressurized Lubricated Bearing**—The bearing which can support steady loads without any relative motion between the journal and the bearing are called hydrostatic bearings.

# OBJECTIVE QUESTIONS

1. The velocity ratio of the belt drive due to slip of the belt—
   (A) Increases
   (B) Decreases
   (C) Remains unchanged
   (D) Unpredictable

2 The Follower is extensively used in air craft engine
   (A) Flat faced (B) Roller
   (C) Knife edge (D) Spherical faced

3 When a body is subjected to transverse vibrations ..... stress is induced in the body
   (A) Compressive (B) Tensile
   (C) Shear (D) Any of the above

4. Which of the following brakes is used in motor cars ?
   (A) Band brake
   (B) Internal expanding brake
   (C) Shoe brake
   (D) Any of the above

5 gear train is used to connect minute hand to hour hand, in a clock mechanism
   (A) Simple (B) Reversed
   (C) Epicyclic (D) Compound

6. A point on a link connecting double slider crank chain traces a ..... path
   (A) Straight line (B) Elliptical
   (C) Hyperbolic (D) Parabolic

7. ..... drive is not a positive drive.
   (A) V-belt (B) Rope
   (C) Flat-belt (D) All of the above

8 Throw of a cam can be defined as the maximum distance of the follower from ..... circle
   (A) Pitch (B) Base
   (C) Prime (D) None of these

9. In a Scott Russel mechanism for straight line, there are ..... movable links
   (A) Two (B) Three
   (C) Four (D) Six

10. .. .. governor is dead weight governor.
    (A) Watt (B) Pickering
    (C) Hartnell (D) Porter

11. .. ... gears are used in a differential of an automobile.
    (A) Double helical (B) Mitre
    (C) Straight level (D) None of these

12. Automobile steering gear is an example of pair.
    (A) Rotary (B) Turning
    (C) Lower (D) Sliding

13. What will be the locus of a point on a thread unwound from a cylinder ?
    (A) Involute (B) Helix
    (C) Straight line (D) Circle

14. .. .. mechanism produces mathematically an exact straight line motion.
    (A) Ackermann (B) Peaucellier's
    (C) Watt (D) None of these

15. In case of cam, the maximum value of the pressure angle is kept as—
    (A) 15° (B) 20°
    (C) 30° (D) 45°

16 Hartnell governor could be classified as ..... type governor
    (A) Dead weight (B) Pendulum
    (C) Centrifugal (D) None of these

17. In order to obtain resistance against wear, best profile is—
    (A) 14° involute stub
    (B) 14° full depth involute
    (C) $14\frac{1^{*}}{2}$ full depth involute
    (D) 20° rack

18. In a continuous system, the number of degree of freedom would be—
    (A) One (B) Two
    (C) Three (D) Four

19. In sugar crushing machinery which of the following types of tooth are provided on the gears used ?
    (A) Cycloidal (B) Involute
    (C) Paraboloid (D) Hyperboloid

20. For a vibrating system, if the damping factor is unity, then the system is ..... damped.
    (A) Under (B) Over
    (C) Critically (D) Zero

21. The governor speed ..... when the sleeve of a porter governor moves upwards
    (A) Decreases (B) Increases
    (C) Constant (D) None of these

22. The frictional torque transmitted by a disc or plate clutch is same as that of ..... bearing.
    (A) Conical pivot
    (B) Flat pivot
    (C) Trapezoidal pivot
    (D) Flat collar

23. ..... governor is used to drive a gramophone.
    (A) Pickering (B) Hartnell
    (C) Watt (D) Porter

24 .. is a transmission dynamometer—
    (A) Hydraulic dynamometer
    (B) Prony brake dynamometer
    (C) Rope brake dynamometer
    (D) None of the above

25. Which of the following is used as a lubricant in a rope brake dynamometer ?
    (A) Water
    (B) Oil
    (C) Grease
    (D) No lubricant is used

26. The size of cam depend on ..... circle—
    (A) Prime (B) Outer
    (C) Base (D) Pitch

27. In a reciprocating engine mechanism the number of links and instaltaneous centres are—
    (A) 3,3 (B) 4,5
    (C) 4,6 (D) 5,5

28. How many links are in peaucellier mechanism ?
    (A) Two (B) Four
    (C) Eight (D) Six

29. The lead screw of a lathe with nut forms a pair
    (A) Turning (B) Screw
    (C) Rolling (D) Sliding

30. For inelastic bodies, the co-efficient of restitution is –
(A) One (B) Greater than one
(C) Zero (D) None of these

31. The pair is said to be a ..... pair when the elements of the pair are kept in contact by the action of external forces—
(A) Self closed (B) Force closed
(C) Lower (D) Higher

32. A quaternary joint, in a kinematic chain, is equivalent to—
(A) One binary joint
(B) Two binary joint
(C) Three binary joint
(D) None of these

33. A kinematic chain is known as a machanism when ..... of the links is fixed
(A) None (B) One
(C) Two (D) All of the above

34 A kinematic chain is known as a mechanism when ..... of the links is fixed
(A) None (B) One
(C) Two (D) All of the above

35 A completely constrained motion can be transmitted with ..... links with pin joints.
(A) Two (B) Four
(C) Five (D) Six

36 Which of the following is an example of spherical pair ?
(A) Ball and socket joint
(B) Bolts and nut
(C) Ball bearing and roller bearing
(D) None of these

37. A universal joint is an example of .. pair
(A) Sliding (B) Lower
(C) Higher (D) None of these

38. What is the unit of mass moment of inertia in S.I. units ?
(A) Kg-m (B) Kg-$m^2$
(C) $m^4$ (D) Nm/Kg

39. The energy possessed by a body for doing work, by virtue of its position is called ..... energy.
(A) Chemical (B) Electrical
(C) Potential (D) Kinetic

40. What is the contact ratio for gears ?
(A) Less than one
(B) Zero
(C) Greater than one
(D) None of these

41 When the number of degrees of freedom(n) is equal to ..... the mechanism forms a structure.
(A) –1 (B) 1
(C) 2 (D) 0

42 The quality of a governor is judged by its—
(A) Power (B) Sensitivity
(C) Stability (D) All of the above

43. A ..... does not require a flywheel
(A) Gas turbine (B) Steam engine
(C) Power press (D) None of these

44. A rock is a gear of—
(A) Infinite module (B) Infinite diameter
(C) Infinite pitch (D) None of the above

45 Helical gears are subjected to ..... stresses.
(A) Bending
(B) Torsional shear
(C) Transverse shear
(D) Hoop

46. Which of the following gears should be recommended for a speed reduction of 50 : 1.
(A) Spur
(B) Differential
(C) Worm and worm wheel
(D) Bevel

47 .. gear train is used in the gear box of an automobile
(A) Inverted (B) Epicyclic
(C) Simple (D) Compound

48 ..... follower is generally used in automobile engines
(A) Roller (B) Flat faced
(C) Knife edge (D) Spherical faced

49 ..... circle is an imaginary circle which by pure rolling action gives the same motion as the actual gear
(A) Clearance (B) Dedendum
(C) Addendum (D) Pitch

50. How many links does a pantograph mechanism contain ?
(A) Two (B) Four
(C) Nine (D) Ten

51. V-belts are usually used for . driver
(A) Short
(B) Long
(C) Both short and long
(D) None of these

52. In the coupling rod mechanism of a locomotive each of the four pairs is a ..... pair.
(A) Screw (B) Turning
(C) Spherical (D) Sliding

53. The balls in a ball bearing are made of . steel.
(A) Tungsten (B) High carbon
(C) Vanadium (D) Nickel-chrome

54. Transmission losses, in a car, will be minimum in ..... gear.
(A) First (B) Second
(C) Third (D) Direct

55 What is the maximum value of pressure angle of cam ?
(A) 8° (B) 20°
(C) 60° (D) 90°

56 If the number of links in a mechanism is 6, the number of pairs would be—
(A) 5 (B) 2
(C) 1 (D) 4

57 Mid-point of the floating link of elliptical trammel traces
(A) A straight line (B) A circle
(C) A parabola (D) An ellipse

58. A hook's joint is used to connect two shafts.
(A) Parallel
(B) Intersecting
(C) Non-parallel intersecting
(D) None of these

59. Type writer constitutes—
(A) An inversion (B) A mechanism
(C) A machine (D) None of these

60. The co-efficient of friction in a well greased ball bearing may be –
(A) 0·1 to 0·25 (B) 0·25 to 0·30
(C) 0·3 to 0·35 (D) None of these

■ coupling is not a flexible coupling.
(A) Oldham's (B) Muff
(C) Universal (D) Bushed PM

62. In case of gears, the contact ratio or engagement factor should be—
(A) 1·1 (B) 1·3 to 1·5
(C) 1·6 to 1·8 (D) 1·9 to 2·1

63. In aero-engines the cylinders are arranged along ..... lines.
(A) Parallel (B) Radial
(C) Perpendicular (D) Any of the above

64. The vibrations at node of shaft are—
(A) Zero (B) Minimum
(C) Maximum (D) Unpredictable

65. For ship, which of the following effects is more dangerous ?
(A) Steering (B) Pitching
(C) Rolling (D) Waving

66. How many degree of freedom are there in a vibrating beam ?
(A) Zero (B) One
(C) Two (D) Three

67 The frequency of damped oscillations as compared to frequency of undamped vibrations, with viscous damping is—
(A) More (B) Less
(C) Same (D) Zero

68. How many crank are there in a single row six cylinder engine ?
(A) One (B) Two
(C) Three (D) Four

69. Motor cycle shock absorbers are generally designed for ..... damping
(A) Resonant (B) Light
(C) Critical (D) Partial

70. A vibrating beam has ..... degrees of freedom.
(A) One (B) Two
(C) Three (D) Four

71. .. .. is used to enlarge or reduce the size of a drawing
(A) Clinometer (B) Pantograph
(C) Clinograph (D) Oscillograph

72. A kinematic chain requires at least . links and . . turning pairs
(A) 2, 3 (B) 3, 4
(C) 4, 4 (D) 5, 4

73. Which of the following motions is imparted by a cam ?
(A) Reciprocating (B) Oscillating
(C) Rotating (D) All of the above

74. For boiler plate riveting ..... head is usually used.
(A) Conical (B) Pan
(C) Snap (D) Counter sunk

75. For motor car cranks shafts ..... steel is widely used.
(A) Silicon (B) High speed
(C) Chrome (D) Nickel

76 In a sleeve and cotter joint, the length of cotter is taken as—
(A) 2 d (B) 3 d
(C) 4 d (D) 4·5 d

77 is a permanent fastening
(A) Screw (B) Rivet
(C) Bolt (D) Key

78. A hot short metal is brittle—
(A) When hot
(B) When cold
(C) Under all conditions
(D) None of the above

79. In cyclic loading, stress concentration is more serious in—
(A) Brittle materials
(B) Ductile materials
(C) Both (A) and (B)
(D) None of these

80. What is the value of Wahl's factor for spring index of 4 ?
(A) 1 2 (B) 1 4
(C) 1·45 (D) 1 8

81 Which type of key is used for mounting shifting gears in gear boxes ?
(A) Saddle key (B) Flat key
(C) Square key (D) Splines

82 type of gear profile is free from interference
(A) Cycloidal (B) Hypocycloidal
(C) Epicycloidal (D) Involute

83 While designing shaft and hub assembly . is taken as the weakest component
(A) Key (B) Shaft
(C) Hub (D) None of these

84. The rolling contact bearings are known as ..... bearings.
(A) Sleeve (B) Plastic
(C) Antifriction (D) None of these

85. The diameter of the rivet hole is usually ..... the nominal diameter of the rivet.
(A) Equal to (B) Less than
(C) More than (D) None of these

86. The thickness of gib in a gib and cotter joint is ..... thickness of cotter.
(A) Equal to (B) Less than
(C) More than (D) None of these

87. The bearings of medium series have capacity ..... over the light series.
(A) 5 to 10% (B) 15 to 20%
(C) 30 to 40% (D) 45 to 55%

88 is the factor of safety for steel and for steady load
(A) 3 (B) 4
(C) 5 (D) 6

89. Residual stresses are present in .. . shafts.
(A) Cast (B) Forged
(C) Cold rolled (D) None of these

90. The piston rod in a steam engine is usually connected to the cross head by ..... joint.
(A) Cotter (B) Knuckle
(C) Universal (D) None of these

91 Rankine's theory is used for ..... materials.
(A) Plastic (B) Ductile
(C) Elastic (D) Brittle

92. If one of the rod of a turnbuckle has left hand threads, then the other rod will have threads.
(A) Left hand (B) Multiple
(C) Right hand (D) Pointed

93. For a mirror polished material the surface finish factor is .....
(A) 0·35 (B) 0·55
(C) 0·75 (D) 1

94. Guest's theory is used for ..... materials
(A) Ductile (B) Plastic
(C) Elastic (D) Brittle

95. A screw is specified by its ..... diameter.
(A) Minor (B) Major
(C) Pitch (D) None of these

96. What is the standard length of the shaft ?
(A) 5 m (B) 6 m
(C) 7 m (D) All of the above

97. The taper on cotter varies from—
(A) 1 in 10 to 1 in 6
(B) 1 in 24 to 1 in 20
(C) 1 in 28 to 1 in 24
(D) None of these

98 The taper on a rectangular sunk key is—
(A) 1 in 10 (B) 1 in 30
(C) 1 in 70 (D) 1 in 100

99 For V-belt, the included angle is usually—
(A) 10° to 20° (B) 30° to 40°
(C) 45° to 55° (D) 65° to 75°

100 In double helical gears the helix angle may be made up to—
(A) 30° (B) 45°
(C) 60° (D) 75°

101. The crowning of the pulleys is done to—
(A) Improve the strength of the pulley
(B) Prevent the belt running off the pulley
(C) Improve the torque transmitted by the pulley
(D) Improve the shape of pulley from safety considerations

102 Considering centrifugal tension in belts, the maximum permissible velocity is—
(A) Proportional to cube root of maximum tension
(B) Proportional to the maximum tension
(C) Inversely proportional to maximum tension
(D) Proportional to square root of maximum tension

103. The inertia of rotating parts of the clutch should be—
(A) Minimum (B) Zero
(C) Maximum (D) None of these

104. Clutch is located between the transmission and the—
(A) Rear axle (B) Differential
(C) Engine (D) Propeller shaft

105. Clutch facings are usually attached to the plate by—
(A) Steel screws (B) Brass rivets
(C) Steel rivets (D) Aluminium screws

106 A clutch is usually designed to transmit maximum torque which is—
(A) Equal to the maximum engine torque
(B) 50% of the maximum engine torque
(C) 150% of the maximum engine torque
(D) None of the above

107 In torque converter maximum torque multiplication occurs at—
(A) High speed (B) Medium speed
(C) Low speed (D) Stop

108. The central gear of an epcyclic gear set is called a—
(A) Internal gear (B) Ring gear
(C) Planet gear (D) Sun gear

109 The component of the torque converter that redirects the flow of oil to impeller is—
(A) Freewheel (B) Impeller
(C) Turbine (D) Stator

110 Critical whirling speed of a shaft is increased by—
(A) Decreasing its length
(B) Increasing its length
(C) Decreasing its diameter
(D) None of these

111. The type of rear axle used on trucks is—
(A) Fully-floating
(B) Semi-floating
(C) Three quarter floating
(D) None of these

112. Central portion of a propeller shaft is made from a—
(A) Steel tube
(B) Steel shaft
(C) Cast iron rod
(D) Gun metal shaft

113. The smallest gears inside the differential casing are—
(A) Pinion gears (B) Ring gears
(C) Side gears (D) Sun gears

114. For limiting friction conditions the maximum tension occurs—
(A) At stopping
(B) At maximum power speed
(C) At starting
(D) At specified speed between starting and maximum power speed

115. A pantograph is a kinematic arrangement—
(A) Which using only lower kinematic pairs
(B) Which using only lower kinematic pairs enlarge or reduce movements
(C) Which using only lower kinematic pairs reproduces drawing to different scales
(D) Which using only lower kinematic pairs are used for guiding cutting tools

## Answers

| | | | | |
|---|---|---|---|---|
| 1. (B) | 2. (B) | 3 (B) | 4. (B) | 5. (B) |
| 6. (B) | 7. (D) | 8 (C) | 9 (B) | 10. (D) |
| 11. (C) | 12. (C) | 13. (A) | 14. (B) | 15. (C) |
| 16. (C) | 17. (C) | 18 (A) | 19. (A) | 20. (C) |
| 21. (B) | 22. (D) | 23. (A) | 24 (D) | 25. (D) |
| 26. (C) | 27. (C) | 28 (C) | 29 (B) | 30. (C) |
| 31. (B) | 32. (C) | 33. (B) | 34 (B) | 35. (B) |
| 36. (A) | 37. (B) | 38 (B) | 39 (C) | 40 (C) |
| 41. (D) | 42. (A) | 43. (A) | 44 (B) | 45. (D) |
| 46. (C) | 47. (D) | 48. (D) | 49. (D) | 50. (B) |
| 51. (A) | 52. (B) | 53. (D) | 54. (D) | 55. (C) |
| 56. (A) | 57. (D) | 58. (C) | 59. (B) | 60. (A) |
| 61. (B) | 62. (B) | 63. (B) | 64. (A) | 65. (B) |
| 66. (C) | 67. (B) | 68. (A) | 69. (C) | 70. (B) |
| 71. (B) | 72. (C) | 73. (A) | 74. (C) | 75. (C) |
| 76 (C) | 77. (B) | 78. (A) | 79. (B) | 80. (B) |
| 81 (D) | 82. (A) | 83. (A) | 84. (C) | 85. (C) |
| 86. (A) | 87. (C) | 88 (B) | 89. (C) | 90. (A) |
| 91 (D) | 92 (C) | 93. (D) | 94. (A) | 95. (B) |
| 96. (D) | 97. (B) | 98 (D) | 99. (B) | 100. (B) |
| 101 (B) | 102. (D) | 103 (A) | 104. (C) | 105. (B) |
| 106 (C) | 107 (D) | 108 (D) | 109. (D) | 110. (A) |
| 111 (A) | 112 (A) | 113 (A) | 114. (C) | 115. (B) |

# 10 ENGINEERING MATERIALS

## Atomic Model

An element is defined as a substance which cannot be decomposed into other substances. The smaller particle of an element which takes part in chemical reaction is known as an 'atom'.

## Dalton's Atomic Theory

States that :

(i) All the atoms of one element are precisely alike, have the same mass but differs from the atoms of other element

(ii) The chemical combination consists of the union of a small fixed number of atoms of one element with a small fixed number of other elements

Various atomic models proposed by scientists over the last few decades are—

(i) Thomson's plum pudding model
(ii) Rutherford's nuclear model
(iii) Bohr's model
(iv) Sommer feld's model
(v) Vector model
(vi) Wave-mechanical model

All substances are made up of atoms. Each atom consists of the following—

(1) Nucleus
(2) Electrons

## Physical Properties

**Elastic Limit**—The greatest stress a material can withstand without permanent elongation, that is when the load is removed the sample will return to its original length.

**Yield Point**—The stress at which appreciable elongation occurs without increase in stress

**Modulus of elasticity**—The ratio of stress to strain within the elastic limit. It is a measure of stiffness.

**Ductility and Brittleness**—The ability of a metal to deform plastically without fracturing. In general, it means deformation under slow stresses instead of sudden impact. Although there are other measures, ductility is most commonly measured by means of elongation and reduction of area in the tensile test.

$$\% \text{ elongation} = \frac{\text{Final gauge length} - \text{original gauge length}}{\text{Original gauge length}} \times 100$$

$$\% \text{ reduction of area} = \frac{\text{Original area} - \text{Final area}}{\text{Original area}} \times 100$$

A material is generally classified as brittle if the percentage elongation is less than 5 in a gauge length of 50 mm.

**Poisson's Ratio**—The ratio of transverse to the longitudinal elastic strain is an axial member, loaded on its longitudinal axis

**Impact Strength**—The ability of a material to withstand shock loading.

## Classification of Materials

The engineering materials may be classified as follows—

(1) Metal (*i.e.* iron, aluminium, copper, zinc, lead etc )
(2) Non-metals (*i.e.* leather, rubber, plastics, asbestos, carbon etc )

## Non-Metals

The common non-metallic materials are leather, rubber, asbestos and plastics.

**Engineering Materials may also be classified as follows—**

(1) **Metals and Alloys**—example steel, copper, aluminium, brasses, bronze, invar, super-alloys

(2) **Ceramic Materials**—MgO, CdS, ZnO, SiC, $BTiO_2$, silica, soda lime, glass, concrete, cement, ferrites, garnets etc

(3) **Organic Materials**—Plastics, PVC, PTFE, polythene, fibres-terylene, nylon, cotton, natural and synthetic rubbers, leather etc

**Difference between Metals and Non-metals—**

| Property | Metals | Non-metals |
|---|---|---|
| 1 Structure | All solid metals have crystalline structure | They exist in amorphic or mesomorphic forms |
| 2. Excitation of valence electron by E.M.F | Easy | Difficult |
| 3 State | Generally solids at room temperature | Gases and solids at ordinary temperature |
| 4 Lustre | Possess metallic lustre | Do not possess metallic lustre |
| 5. Conductivity | Good conductor of heat and electricity | Bad conductors of heat and electricity |
| 6. Malleability | Malleable | Non malleable |
| 7 Ductility | Ductile | Not ductile |
| 8 Hardness | Generally hard | Hardness varies |
| 9 Electrolysis | Form anions | Form anions |
| 10 Density | High density | Low density |

**Composites**

(A) Metals and Alloys and Ceramics—
  (i) Steel reinforced concrete
  (ii) Dispersion hardened alloys

(B) Metals and Alloys and Organic Polymers—
  (i) Vinyl-coated steel
  (ii) Whisker-reinforced plastics

(C) Ceramics and Organic Polymers—
  (i) Fibre-reinforced plastics
  (ii) Carbon-reinforced rubber

**Classification of Electrical Engineering Materials**—The electrical engineering materials may be classified into the following four types

(A) Conductors (B) Semiconductors
(C) Insulators (D) Magnetic materials

**Electrical Properties of Materials**—Important electrical properties of materials are :

(i) Resistivity.
(ii) Conductivity.
(iii) Temperature co-efficient of resistance.
(iv) Dielectric strength
(v) Thermoelectricity
(vi) Electrochemical phenomena-as in storage batteries.
(vii) Electrophysical effects-as in contact potentials.
(viii) Electro-mechanical effects-as in radars.

**Super Conductivity**—Super conductivity state can be abolished by the application of an external magnetic field or produced by a sufficiently large current flowing through the conductor

**Mechanical Properties of Metals**—Important machanical properties of metals are as below .

(i) Strength (ii) Elasticity
(iii) Plasticity (iv) Ductility
(v) Malleability
(vi) Toughness or tenacity
(vii) Brittleness (viii) Hardness
(ix) Fatigue (x) Creep

**Testing of Materials**—Materials are tested for one or more of the following purposes :

(i) To assess numerically the fundamental mechanical properties of ductility, malleability, toughness etc.
(ii) To check chemical composition.
(iii) To determine suitability of material for a particular application.
(iv) To determine data *i.e.* force deformation (or stress) values to draw up sets of specifications upon which the engineer can base his design.
(v) To determine the surface or surface defects in raw material or processed parts

**Classification of Tests**—Tests on material may be classified as :

(i) Non-destructive tests
(ii) Destructive Tests

In non-destructive testing a component does not break and even after being tested. So it can be used for the purpose for which it was made.

**Examples**

Radiography, ultrasonic inspection etc.

In destructive testing the component or specimen either breaks or remains no longer useful for further use

**Examples**

Tensile test, impact test, torsion test etc.

(i) **Non-destructive tests**—Non-destructive tests may be defined as those which in a specific context would not damage the material being examined to an extent such that it is rendered useless for further for which it was originally meant.

The various methods used for nondestructive testings are as follows :

(i) X-ray radiography
(ii) Gama radiography
(iii) Magnetic particle inspection
(iv) Ultrasonic testing

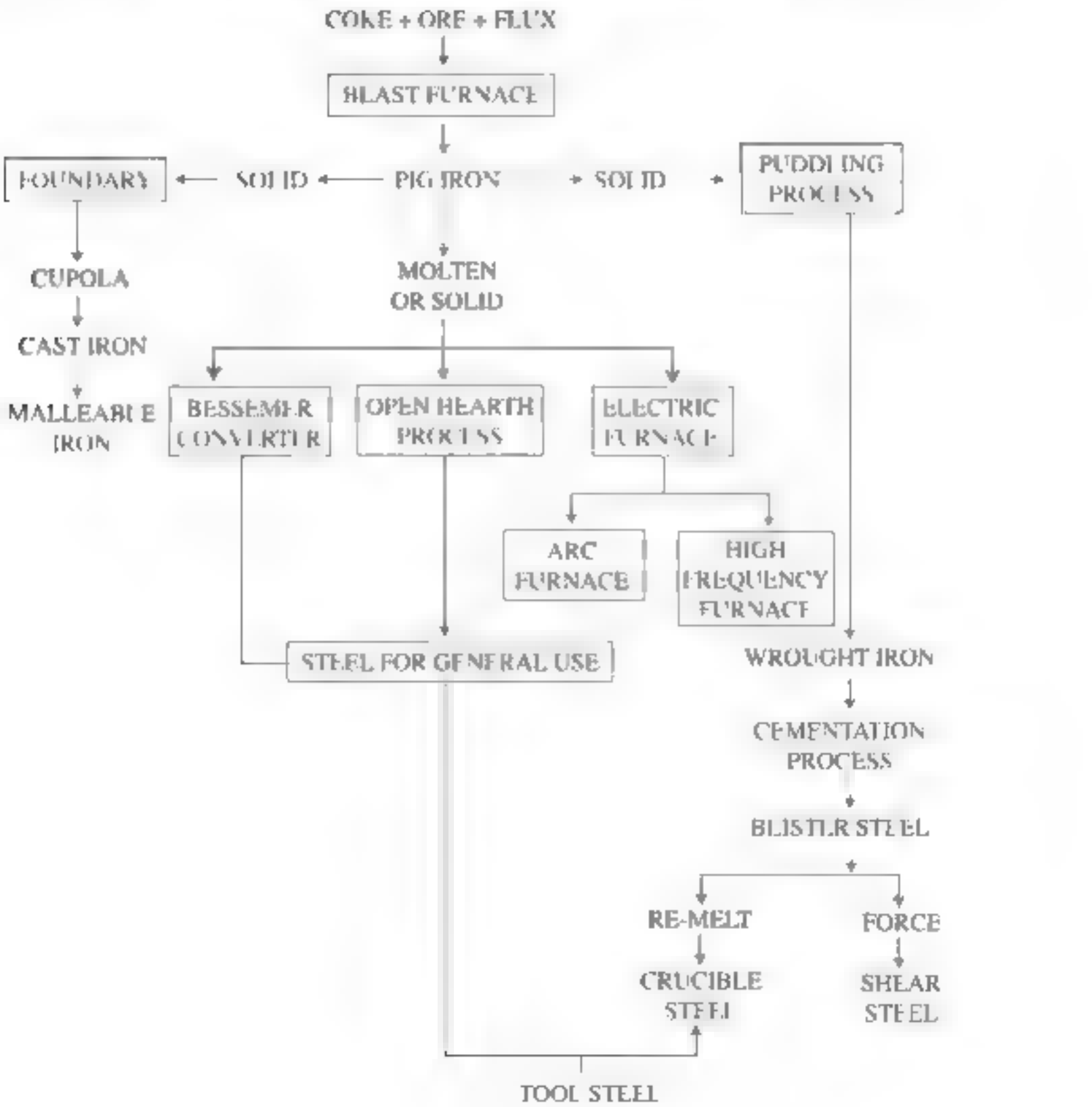
(v) Electrical method
(vi) Damping test

(ii) **Destructive Tests** – The component or specimen after being destructively tested either breaks or remains no longer useful for further use. Examples of destructive tests are as : tensile test, impact test, torsion test, bend test, fatigue test etc.

## Iron Ores

| S. N. | Name of the ore | Iron content | Chemical formula | Countries where available |
|---|---|---|---|---|
| 1. | Magnetite | 72·5% | $Fe_3O_4$ | India, Salem district (Chennai) Sweden U.S.A., U.S.S.R. |
| 2. | Haematite | 65 to 70% | $Fe_2O_3$ | India (Bihar, Orissa, Andhra, Madhya Pradesh, Mysore), U.S.A. |
| 3 | Limonite | 60% | $2Fe_2O_3\ 3H_2O$ | France, U.K., Spain, India. |
| 4 | Siderite | 40 to 44% | $FeCO_3$ | U.K., U.S.S.R., India (Raniganj-Bengal) |

## Flow Sheet for Production of Iron and Steel



**Cast Iron may be classified as –**

(i) Grey cast iron
(ii) White cast iron
(iii) Nolted cast iron
(iv) Nodular cast iron
(v) Malleable cast iron
(vi) Alloy cast iron

**Carbon Steels are classified as—**

(i) Low carbon steel or mild steel
(ii) Medium carbon steels
(iii) High carbon steels

**Important non-ferrous metals are as follows—**

(i) Aluminium
(ii) Copper
(iii) Lead
(iv) Tin
(v) Zinc
(vi) Magnesium
(vii) Nickel

**A bearing alloy should have the following characteristics—**

(i) Good wearing quality
(ii) Low co-efficient of friction
(iii) High thermal conductivity
(iv) High melting point
(v) Good casting qualities
(vi) Ability to withstand continuous bearing pressure and impact
(vii) Ability to work satisfactorily at the rubbing speed at which it is required to run
(viii) Low shrinkage after casting
(ix) Desired plasticity under the load it is called upon to bear
(x) Economy in cost
(xi) Non-corrosive property

**Requirements of a heat insulating material**—The main requirements of a thermal or heat insulating material are given below :

(i) Thermal stability
(ii) Chemical stability
(iii) Physical stability
(iv) Low thermal conductivity
(v) Resistance to moisture
(vi) Low specific heat
(vii) Low specific gravity
(viii) Odourless
(ix) Non-inflammability

**Classification of heat insulating material—**

The heat insulator may be classified in two ways .

(i) Organic heat insulators
(ii) Inorganic heat insulators

**Organic heat insulators include—**

(i) Wool
(ii) Cattle hair
(iii) Eelgrass
(iv) Cotton wool
(v) Cork board
(vi) Silk
(vii) Wood pulp
(viii) Sugarcane fibre
(ix) Sawdust
(x) Card board
(xi) Paper
(xii) Leather

**Inorganic heat insulators include—**

(i) Air (still)
(ii) Slag wool
(iii) Mineral wool
(iv) Glass wool
(v) Aluminium foil
(vi) Diatomaceous earth
(vii) Charcoal
(viii) Slag
(ix) Wood ashes
(x) Gypsum (powder)
(xi) Coke (powder)

**Solid Solution**—Solid solution may be defined as a solution in the solid state which consists of two kinds of atoms combined in one type of space lattice.

Solid solutions are conductors but not so good as the pure metals on which they are based. Some examples of solid solutions are

(i) Cu-Zn alloys (Brass)
(ii) Ni-Cu alloys (Monel metal)

(iii) Au-Ag alloys
(iv) Ag-Cu alloys (sterling silver)
(v) Fe-Cu-Ni alloys (certain stainless steels)
(vi) Fe-C alloys (steels)

**Types of Solid Solutions**— Solid solutions occur in either of two distinct types—

1. Substitutional solid solution—
   (i) Disordered, (ii) Ordered
2. Interstitial solid solution.

## OBJECTIVE QUESTIONS

1. Babbit metal is ..... base alloy.
   (A) Tin (B) Copper
   (C) Lead (D) Tungsten

2. . ... does not certain tin as an alloying element.
   (A) Babbit metal (B) White metal
   (C) Solder (D) All of the above

3. In 18-4-1 HSS (high speed steel) the percentage of chromium is—
   (A) 1% (B) 4%
   (C) 18% (D) 20%

4. ..... is present in high percentage in magnet steel..
   (A) Aluminium (B) Tungsten
   (C) Zinc (D) Copper

5. Hardness of cementite is of the order of ..... BHN.
   (A) 200 (B) 500
   (C) 1400 (D) 1100

6. With which of the following polymerisation is associated ?
   (A) Copper
   (B) Zinc
   (C) Thermoplastic plastics
   (D) None of these

7. Under microscope, ferrite appears—
   (A) White (B) Light
   (C) Dark (D) None of these

8. The pH value of neutral solution is—
   (A) Equal to 7 (B) Less than 7
   (C) Greater than 7 (D) None of these

9. Foundry crucible is made of—
   (A) Graphite (B) Lead
   (C) Cast iron (D) Mild steel

10. Dies, drills and taps contain ..... carbon
    (A) Below 0·4% (B) Below 0·8%
    (C) Above 1% (D) Above 2·5%

11 ..... can be easily drawn into wire
   (A) Cast iron (B) Zinc
   (C) Tin (D) Copper

12. .. ... structure is obtained by austempering process of heat treatment.
    (A) Sorbite (B) Bainite
    (C) Martensite (D) Troostite

13 .. is better suited for lighter duty bearings.
   (A) Phosphor bronze
   (B) Plastics
   (C) White metal
   (D) Monel metal

14 Corundum contains more than 95%.
   (A) MgO (B) $SiO_2$
   (C) $Al_2O_3$ (D) Steel

15 What is the percentage of carbon present in cold rolled steel sheets ?
   (A) 0·02% (B) 0·1%
   (C) 0·25% (D) 0·35%

16 is the binding material in cemented carbides.
   (A) Nickel (B) Cobalt
   (C) Carbon (D) Vanadium

17. Preheating is essential in welding—
    (A) High speed steel
    (B) Cast iron
    (C) All non-ferrous materials
    (D) None of these

18 ..... is not the neutral refractory material.
   (A) Graphite (B) Kaynite
   (C) Chromite (D) Dolomite

19. Pipes of bicycle frames are made of ..... steel
(A) Cast (B) Hot rolled
(C) Carbon chrome (D) Dead mild

20. ..... Cast iron has the maximum tensile strength.
(A) White (B) Grey
(C) Nodular (D) Pig

21. As percentage of carbon increases in steel its .. decreases.
(A) Corrosion resistance
(B) Ultimate strength
(C) Hardness
(D) Ductility

22. The melting point is the lowest for—
(A) Low carbon steel
(B) High carbon steel
(C) Cast iron
(D) Wrought iron

23. ..... structure has maximum hardness
(A) Troostile (B) Pearlite
(C) Martensite (D) Sorbite

24. Austenite is a solid solution of carbon in iron.
(A) Alpha (B) Beta
(C) Gamma (D) Delta

25 .. process needs no quenching
(A) Case hardening
(B) Flame hardening
(C) Induction hardening
(D) Nitriding

26. .. are usually made of mild steel
(A) Fish plates (B) Angle irons
(C) Die blocks (D) Shear blades

27. ..... is commonly used for making household utensils
(A) Duralumin (B) Hindalium
(C) γ - alloy (D) Magnalium

28. ..... has least co-efficient of expansion.
(A) Manganin (B) Invar
(C) Constantan (D) Duralumin

29 ..... will exhibit viscoelastic behavior
(A) Steel
(B) Diamond
(C) Organic polymers
(D) Neoprene

30. Ceramic cutting tools are made of—
(A) Tungsten carbide
(B) Silicon oxide
(C) Mixture of oxides of aluminium
(D) None of these

31. For the production of ..... L.D. converter is used
(A) Steel (B) Polythene
(C) Graphite (D) Cast iron

32 Ball bearings are generally made of—
(A) Carbon steel
(B) Carbon chrome steel
(C) Stainless steel
(D) Grey cast iron

33 . . is the essential gradient of any hardened steel
(A) Carbon (B) Pearlite
(C) Austenite (D) Martensite

34. Out of the following which is the amorphous material ?
(A) Lead (B) Brass
(C) Glass (D) Silver

35 .. structure in obtained if steel is quenched in water
(A) Sorbite (B) Pearlite
(C) Troostite (D) Martensite

36. In metals the size of course grains is greater than—
(A) 0·5 mm (B) 0·05 mm
(C) 0·005 mm (D) 0·0005 mm

37 . .. has high tendency to get work hardened.
(A) Lead (B) Aluminium
(C) Brass (D) Silver

38 ..... structure can be studied by naked eye
(A) Atomic (B) Grain
(C) Micro (D) Macro

39. Alloys of magnesium are—
(A) Easy to machine (B) Magnetic
(C) Light (D) Prone to corrosion

40. High speed steel belongs to the category of ..... steel
(A) Alloy (B) Stainless
(C) Low carbon (D) High carbon

41 In blast furnace ..... is used as fuel
(A) Producer gas (B) Coal
(C) Coke (D) Diesel

42. .. ... is the hardest known material
(A) Cemented carbide
(B) Ceramic
(C) Diamond
(D) Alloy steel

43. Babbit metal is a ..... alloy.
(A) Zinc base (B) Lead base
(C) Tin base (D) None of these

44. .. is used for bearing liner.
(A) Brass (B) Bronze
(C) Gun metal (D) Babbit metal

45. Under microscope pearlite appears as
(A) White (B) Light
(C) Dark (D) Finger print

46. ..... test is a non-destructive test.
(A) Impact (B) Charpy
(C) Radiography (D) Tensile

47. By which of the following heat treatment processes, a small selected portion of the job can be hardened ?
(A) Nitriding
(B) Cyaniding
(C) Pack hardening
(D) Flame and induction hardening

48. .. is obtained by isothermal hardening operation.
(A) Cementite
(B) Sorbite
(C) Acicular troostite
(D) Barute

49. . .. is the most important element which controls the physical properties of steel
(A) Carbon (B) Chromium
(C) Vanadium (D) Tungsten

50. What is the range of Mohr's scale ?
(A) 1 to 4 (B) 1 to 10
(C) 1 to 14 (D) 1 to 16

51. .. .. has maximum malleability.
(A) Aluminium (B) Copper
(C) Lead (D) Wrought iron

52 Nickel is ..... material
(A) Dielectric (B) Ferro-electric
(C) Ferro-magnetic (D) Dia-magnetic

53 What is the product of cupola called ?
(A) Wrought iron (B) Cast iron
(C) Mild steel (D) Pig iron

54. With which of the following age-hardening is related ?
(A) Cast -iron (B) Gun metal
(C) Duralumin (D) German silver

55. Which of the following hardening processes is not generally used for steels ?
(A) Nitriding (B) Cyaniding
(C) Age hardening (D) None of these

56. Steel can be hardened quickly by ..... process
(A) Carbunising
(B) Cyaniding
(C) Induction hardening
(D) None of these

57 ..... surface hardening process gives maximum hardness to the surface.
(A) Pack hardening
(B) Nitriding
(C) Cyaniding
(D) Induction hardening

58. The chisel used for cutting steel sheets is usually—
(A) Annealed
(B) Normalised
(C) Hardened
(D) Hardened and tempered

59. The corrosion resistance property of stainless steels is due to the presence of—
(A) Manganese (B) Chromium
(C) Cobalt (D) Silicon

60. The chisels are generally made of ..... steel.
(A) High carbon (B) Mild
(C) Medium carbon (D) Dead mild

61 Slip gauges are generally made of—
(A) Alloy steel (B) Cast iron
(C) Bronze (D) None of these

62. Gold is ..... material.
(A) Ferro-electric (B) Ferro-magnetic
(C) Dia-magnetic (D) Para-magnetic

63. Monel metal is an alloy of—
(A) Cu and Cr (B) Ni and Cu
(C) Ni and Cr (D) Cu, Ni and Cr

64. ..... has excellant resistance to acids
(A) Permalloy (B) Constantan
(C) Hastelloy (D) Monel metal

65. ..... is not a ceramic material
(A) Glass (B) Bakelite
(C) Clay (D) Aluminium oxide

66. ..... material show direction dependent properties.
(A) Orthotropic (B) Isotropic
(C) Anisotropic (D) None of these

67. ..... is a copper free alloy.
(A) German silver (B) Muntz-metal
(C) White metal (D) Gun metal

68. Heating elements are generally made of—
(A) Invar (B) Perminvar
(C) White metal (D) Nichrome

69. ..... is not a constituent of alnico steel
(A) Cobalt (B) Copper
(C) Nickel (D) None of the above

70. ..... steel is widely used for rails of a railway track
(A) Mild (B) High carbon
(C) Silicon (D) Nickel

71. ..... iron is the magnetic allotrope of iron.
(A) $\alpha$ (B) $\beta$
(C) $\gamma$ (D) $\delta$

72. Which of the following properties pertain to cast iron ?
(A) Resistance (B) Ductility
(C) Wear resistance (D) Toughness

73. To which of the following is the proof stress related ?
(A) Elongation (B) Necking
(C) Yielding (D) Fracture

74. ..... affect the fatigue strength least.
(A) Stress concentration
(B) Magnitude of mean stress
(C) Temperature
(D) Frequency

75. Babbit metal is alloy of—
(A) Cu and Zn (B) Sn and Cu
(C) Sn, Cu and Sb (D) Sn, Cu, Sb and Pb

76 Ball bearing are generally made of—
(A) Carbon steel
(B) Cast iron
(C) Carbon chrome steel
(D) Stainless steel

77. High speed steel should have—
(A) Wear resistance (B) Hardenability
(C) Toughness (D) Both (B) and (C)

78. The purpose of annealing is to—
(A) Induce stress (B) Harden the surface
(C) Induce hardness (D) Remove stresses

79. 18–4–1 High speed steel contains—
(A) 4% chromium (B) 1% carbon
(C) 0·7% carbon (D) 4% carbon

80. Central portion of a propeller shaft is made from a—
(A) Steel tube (B) Steel shaft
(C) Cast iron rod (D) Gun metal shaft

81 Air brakes are mostly used in case of—
(A) Jeeps (B) Cars
(C) Trucks (D) Three-wheelers

82. Silicon steel is widely used in—
(A) Chemical industry
(B) For nuts and bolts
(C) Electrical industry
(D) For cutting tools

83. The percentage of carbon in low carbon steel is—
(A) 0·15 (B) 0·5
(C) 0·7 (D) 1·3

84. Shot peening—
(A) Improves fatigue life of small parts
(B) Refines the grain structure
(C) Changes the crystalline structure of material
(D) Is done at recrystallization temperature

85. The critical points for steels—
(A) Occur at same temperature for all steels
(B) Cause change in physical properties
(C) May change in number on heating or cooling
(D) Change the chemical composition of steel

86. Galvanizing is generally done on—
(A) Cast iron
(B) Non-metallic substances
(C) Low-carbon steel
(D) Non-ferrous metals

87. Which of the following is a fuel used in fast reactors ?
(A) Chromium (B) Plutonium
(C) Graphite (D) Zirconium

88. Heavy water is used in atomic power plants as—
(A) Moderator (B) Lubricants
(C) Fuel (D) Source of energy

89 Which adhesive is used for plywood work ?
(A) Gum (B) Castor oil
(C) Fevicol (D) Guar gum

90. Which of the following is the lightest ?
(A) Atom (B) Molecule
(C) Proton (D) Electron

## Answers

| | | | | |
|---|---|---|---|---|
| 1. (A) | 2. (B) | 3 (C) | 4 (B) | 5. (C) |
| 6. (C) | 7. (B) | 8 (A) | 9 (A) | 10. (C) |
| 11. (D) | 12. (B) | 13. (A) | 14. (C) | 15. (B) |
| 16. (B) | 17. (B) | 18 (D) | 19 (C) | 20. (C) |
| 21. (D) | 22. (C) | 23. (C) | 24 (C) | 25 (D) |
| 26. (B) | 27. (D) | 28 (B) | 29. (D) | 30. (C) |
| 31. (A) | 32. (B) | 33. (D) | 34. (C) | 35 (D) |
| 36. (B) | 37. (C) | 38 (D) | 39 (C) | 40. (A) |
| 41. (C) | 42. (C) | 43. (C) | 44. (D) | 45. (D) |
| 46. (C) | 47. (D) | 48. (C) | 49. (A) | 50. (B) |
| 51. (C) | 52. (C) | 53. (B) | 54. (C) | 55. (C) |
| 56. (C) | 57. (B) | 58. (D) | 59. (B) | 60. (A) |
| 61 (A) | 62. (C) | 63. (B) | 64. (C) | 65. (B) |
| 66 (C) | 67. (C) | 68 (D) | 69. (B) | 70. (B) |
| 71. (A) | 72 (C) | 73 (A) | 74. (D) | 75. (D) |
| 76 (C) | 77. (D) | 78. (D) | 79. (C) | 80. (A) |
| 81. (C) | 82 (C) | 83 (A) | 84. (A) | 85. (B) |
| 86 (C) | 87 (B) | 88 (A) | 89 (C) | 90. (D) |

# 11 PRODUCTION ENGINEERING, INDUSTRIAL ENGINEERING AND MANAGEMENT

## Plant Organisation

**Plant**—A plant is a place where men, material, money, equipment, machinery etc are brought together for manufacturing products.

**Organisation**—Organisation is the pattern of ways in which a large number of people engaged in a complexity of tasks relate themselves to each other in systematic establishment and accomplishment at mutually agreed purpose.

**Principles of Organisation**—

(i) Consideration of objectives
(ii) Relationship of basic components
(iii) Responsibility and authority
(iv) Span of control
(v) Dividing and grouping work
(vi) Effective delegation
(vii) Communication
(viii) Line and staff relationships
(ix) Balance, stability and flexibility

**Line or Scalar Organisation**—Authority and responsibility flow vertically in an unbroken straight line from one level to another is called line or scalar organisation

**Advantages**—

(i) Simplicity
(ii) Flexibility
(iii) Quick decisions
(iv) Communication
(v) Executive development
(vi) Unified control
(vii) Fixed responsibility
(viii) Effective discipline
(ix) Economy

**Demerits**—

(i) Overburdening
(ii) Instability
(iii) Lack of specialisation
(iv) Autocratic control
(v) Difficulty in staffing
(vi) Inadequate communication

**Functional Organisation**—In the functional organisation, the enterprise is divided into a number of functional departments. Every functional department serves the rest of the organisation

**Advantages**

(i) Specialisation
(ii) Easier staffing
(iii) Simplified control
(iv) Better supervision
(v) Scope for expansion
(vi) High efficiency

**Demerits**

(i) Lack of co-ordination
(ii) Delayed decisions
(iii) Poor discipline
(iv) Low morale
(v) Lack of executive development
(vi) Uneconomical
(vii) Divided responsibility

**Line and Staff Organisation**—This organisation is a combination of line and functional organisation

**Advantages**

(i) Discipline
(i) Balanced decision
(iii) Planned specialisation
(iv) Undivided responsibility
(v) Flexibility
(vi) Staffing and developments

**Demerits**

(i) Ineffective staff

(ii) Conflicts

(iii) Expensive

(iv) Lack of co-ordination

**Scientific Management**—Scientific management may be defined as a systematic to manage the enterprise on the basis of observation, experimentation and rotational decision.

**Principles**—

(i) Scientific method of production

(ii) Standardisation

(iii) Time and motion study

(iv) Costing and cost control

(v) Production planning and control through functional foremanship

(vi) Scientific selection, training and remuneration of the workers.

**Aims**—The aims of scientific management are

(i) Placement of right person on the right job through scientific selection and training

(ii) Reduction in cost of production by rational planning and regulation of cost control techniques.

(iii) Increase in rate of production by use of standardised tools, equipment and methods.

(iv) Elimination of wastage in the use of resource time and methods of operation

(v) Relative wage payment according to the efficiency of the worker

(vi) Improvement in the quality of the products by research, quality control and inspection devices.

(vii) Ensuring steady flow of standard goods at fixed price.

**Functions of management can be classified into the following six activities –**

(i) Planning

(ii) Organising

(iii) Staffing

(iv) Directing

(v) Controlling

(vi) Co-ordinating

**Elements of Communication –**

(i) Communicator

(ii) Message

(iii) Communication symbol

(iv) Communication channel

(v) Receiver

**Some important factors affecting plant location are—**

(i) Nearness to raw materials

(ii) Transport facilities

(iii) Nearness to markets

(iv) Availability of labour

(v) Availability of fuel and power

(vi) Availability of water

(vii) Climatic conditions

(viii) Financial and other aids

(ix) Land

(x) Community attitude

**Few sound principles of plant layout are—**

(i) Integration

(ii) Minimum movements and material handling

(iii) Smooth and continuos flow

(iv) Cubic space utilization

(v) Safe and improved environment

(vi) Flexibility

**Process Layout**—It is also known as functional layout and is characterised by keeping similar machines or similar operations at one location/place

**Advantages**

(i) Better quality of the product

(ii) Less waiting time

(iii) Specialist supervisors

(iv) Flexibility

(v) Low investment due to less number of machines

**Demerits**

(i) There may be lack of co-ordination between different facilities.

(ii) Difficult to allot production priority

(iii) It is necessary to have good planning to avoid wastage of time.

**Product Layout** – It is also known as line layout. It implies that various operations on a

product are performed in a sequence and the machines are placed along the product flow line.

**Advantages**

(i) Operations can be carried out quickly
(ii) Processing time is less
(iii) Material handling cost is less/low
(iv) Automatic material handling possible
(v) Production control is easy
(vi) Less space required

**Demerits**

(i) Speed of production is slow
(ii) Additional processes are not permitted to rigidity of layout.
(iii) Material lying in queue is more.
(iv) The material has to travel for a longer distance.

## PPC (Production, Planning and Control)

**Production**—It involves sequence of operations that transform raw materials into the desired shape and size.

**Planning**—It begins with the analysis of given data, on the basis of which a scheme of utilisation of firm s services can be outlined.

**Control**—It involves supervising operations with the aid of control mechanisms and feedback information about the process of work.

**Scheduling**—"The fixation of time and date for each operation and also the time required to perform the entire series as routed and making allowance for other factors concerned"

**There are three types of schedules—**

(i) Master schedule
(ii) Manufacturing schedule
(iii) Daily operating schedule

**Follow-up**—Follow-up or checking progress is the function of a watching and recording the progress of jobs as per schedule and making necessary adjustments in case of emergencies

**Types of Production—**

(i) Job order production
(ii) Batch or quality production
(iii) Mass production

**Forecasting**—Forecasting means estimation of type, quantity and quality of future work.

**Need of Forecasting**—Sales forecasting is essential because

(i) It determines the volume of production and the production rate.
(ii) It forms basic for production budget, labour budget, material budget etc.
(iii) It suggests the need for plant expansion.
(iv) It emphasizes the need for product research development
(v) It suggests the need for changes in production method
(vi) It helps establishing pricing policies
(vii) It helps deciding the extent of advertising, product distribution etc.

**Forecasting Technique**—Following techniques are used for forecasting :

(i) Historical estimate.
(ii) Estimation by salesman
(iii) Statistical analysis.
(iv) Moving average data method
(v) The exponential smoothing method
(vi) Market research by suitable questionnaire.
(vii) Survey or buyer's views
(viii) Collective opinion

**Inspection**—Inspection means checking the acceptability of the manufactural product.

**Kinds of Inspection—**

(i) Roving, process, petrolling and floor inspection.
(ii) Fixed inspection
(iii) Key-point
(iv) Final inspection

**Control Charts**—A control chart is a day to day graphical presentation of the collected information it detects variations in the processing and warns if there is any departure from the specified tolerance limits. The various types of control charts are :

(A) Variable or measurements charts—
(i) $\bar{X}$-chart
(ii) R-chart
(iii) $\sigma$-chart

(B) Attribute charts—
(i) P-chart
(ii) np-chart
(iii) C-chart
(iv) U-chart

**Work Study**—According to British standard institute work study is a term for those techniques

particularly 'method study' and 'work measurement'. Which are used in the examination of human work in all its contexts and which lead systematically to the investigation of all the factors which affect the efficiency of the situation.

**Standard Time—**

Standard time

= Average time × Rating factor + Other allowances

**Performance Rating—**

Performance rating

$$= \frac{\text{Observed performance}}{\text{Normal performance}} \times 100$$

**Symbols used in work study—**

- ○ → Operation
- ◁ → Storage
- □ → Inspection
- D → Delay
- ⇨ → Transport

**Steps involved in method study—**

(i) Select ..... the work and area to be studied
(ii) Define the problem
(iii) Record all relevant files
(iv) Examine all relevant facts critically
(v) Develop ..... a new most economical and effective method
(vi) Sell ..... the new method and find out discripencies
(vii) Install ..... the new method as standard practice
(viii) Maintain ..... the new method by regular checks

**Recording Techniques used in Method Study—**

(i) The operation process chart
(ii) The outline process chart
(iii) The flow process chart (material)
(iv) The flow process chart (man)
(v) The multiple activity chart
(vi) Two handed process chart
(vii) The simultaneous motion cycle chart
(viii) The flow diagram
(ix) The string diagram
(x) The travel chart

**Financial Management and Budgeting—** Finance can be said as an activity concerned with planning, raising, controlling and administrating of funds used in the business

**The Scope of Financial Managements—**

(i) Estimating the requirements
(ii) Determining the capital structure
(iii) Sources of funds
(iv) Utilisation of funds
(v) Disposal of surplus
(vi) Management of cash
(vii) Financial controls

**Some Common Sources of Raising Finances are—**

(i) Industrial banks
(ii) Unit trust of India
(iii) Industrial finance corporation of India
(iv) Life insurance corporation of India
(v) Industrial development bank of India
(vi) [redacted]
(vii) Debentures
(viii) Mutual funds

**Budgets may be classified as follows—**

(A)—
(i) Fixed Budget
(ii) Variable Budget

(B)—
(i) Main Budget
(ii) Master Budget
(iii) Subsidiary Budget

**Management Information System (M.I.S.)—** Management information system aims at providing information to the management to take timely, sound and accurate decisions

**Analysis—**

(i) Problem recognition
(ii) Problem identification

**Synthesis of Problem—**

(i) Preparation of flow chart
(ii) Examination of information documents
(iii) Working out quantities
(iv) Establishing inputs and outputs
(v) Assigning the task and responsibilities
(vi) Running in parallel

# OBJECTIVE QUESTIONS

1. .. activities are the activities for which total float is equal to zero.
   (A) Dummy (B) Subcritical
   (C) Critical (D) Supercritical
2. . layout provides greater flexibility
   (A) Product (B) Process
   (C) Fixed position (D) Group
3. In a shop heavy jobs are lifted by means of—
   (A) Fork lift (B) Conveyors
   (C) Hoists (D) Overhead crane
4. . is a group incentive plan.
   (A) Stanlon plan (B) Bedaux plan
   (C) Rowan plan (D) None of the above
5. . .. chart is not associated with work study.
   (A) Gnatt
   (B) SINO
   (C) Multiple activity
   (D) None of these
6. One TMU (Time Measurement Unit) equals—
   (A) 0·00001 hours
   (B) 0·00003 hours
   (C) 0·00006 hours
   (D) 0·00008 hours
7. Large inventories are permitted in case of items
   (A) Only C (B) Only B
   (C) A and B (D) B and C
8. .. plan is a bonus plan in which allowance is determined in terms of time for each unit of output instead of money.
   (A) Rowan (B) Bedaux
   (C) Group (D) Hour-for-hour
9. . introduced therbligs.
   (A) Blanket (B) Gilbreath
   (C) Cooper (D) Adam
10. In ..... production acceptance sampling is widely used.
    (A) Job (B) Batch
    (C) Mass (D) All of the above
11. In ..... industry routing is essential
    (A) Job order
    (B) Assembly
    (C) Mass production
    (D) Process
12. PERT has ..... time estimate
    (A) One (B) Two
    (C) Three (D) Four
13. In which of the following cases, bar charts are suitable ?
    (A) Large projects (B) Major works
    (C) Minor works (D) All of the above
14. Queing theory is associated with which of the following ?
    (A) Production time (B) Waiting time
    (C) Scales (D) Inspection time
15. Which class of elements in ABC analysis are generally large in number ?
    (A) A (B) B
    (C) C (D) Unpredictable
16. In which of the following are the specifications of work operations and their sequence described ?
    (A) Route card (B) Work order
    (C) Job order (D) Operation chart
17. . .. is the basic tool in work measurement
    (A) SIMO chart (B) Process chart
    (C) Bar chart (D) Stop watch
18. For which of the following stop watch is not needed ?
    (A) R-chart
    (B) Micromotion study
    (C) SIMO chart
    (D) None of these
19. With which of the following is slack or slack time associated ?
    (A) An event
    (B) An activity
    (C) Both (A) and (B)
    (D) None of the above

20. The slack on various events at critical path on a PERT/CPM chart –
    (A) Decreases continuously
    (B) Increases continuously
    (C) Remains constant
    (D) Unpredictable

21. Availability is a function of—
    (A) System effectiveness
    (B) Maintainability
    (C) Reliability
    (D) Both (B) and (C)

22. System cost includes the total amount for—
    (A) Service life support
    (B) Development
    (C) Production
    (D) All of the above

23. ..... is a measure of the net worth, of value of a system to the uses.
    (A) Performance capability
    (B) Availability
    (C) System effectiveness
    (D) Maintainability

24. .. is the internal during which of the system is not in an acceptable operation condition.
    (A) Maintainability
    (B) Man-hours
    (C) Administrative time
    (D) Down time

25. is the probability that a failed system is restored to operable condition in a specified down time
    (A) System effectiveness
    (B) Maintainability
    (C) Availability
    (D) Man-hours

26. OC curves are used for the selection lots by—
    (A) Attributes
    (B) Variables
    (C) Variables and attributes
    (D) Random

27. In sampling plans, N indicates –
    (A) Acceptance number
    (B) Rejection number
    (C) Sample size
    (D) Lot size

28 X-rays are used in—
    (A) Ultrasonic testing
    (B) Thermal methods
    (C) Magnetic testing
    (D) Radiography

29. Air gauge is a ..... comparator
    (A) Electrical (B) Electronics
    (C) Pneumatic (D) Mechanical

30. Size bar is used for measuring.
    (A) Height (B) Angle
    (C) Length (D) Area

31 The concept of prevention and control comes under—
    (A) Managerial (B) Engineering
    (C) Planning (D) Statistical

32 Material handling is more in case of . inspection.
    (A) Patrol (B) First piece
    (C) Floor (D) Centralised

33 The basic objective of quality control in any organisation is—
    (A) To build up customer good will
    (B) To ensure control
    (C) To achieve optimum cost
    (D) All of the above

34. In CPM the performance of a specific task is known as—
    (A) Activity (B) Event
    (C) Contract (D) Dummy

35 Which of the following is not an important parameter of purchasing ?
    (A) Right source (B) Right price
    (C) Right sale (D) Right quantity

36. Which of the following is not the advantage of planning ?
    (A) Planning targets
    (B) Removing disorders
    (C) Fixing priorities
    (D) Relaxation priorities

37. The total cost in break even analysis consists of –
    (A) Variable cost
    (B) Fixed cost
    (C) Fixed cost + variable cost
    (D) Fixed cost + overhead cost + profits

38. ..... ensures a part of the saving to the worker and rest to the employer.
    (A) Piece rate system
    (B) Taylor plan
    (C) Halsey premium plan
    (D) Emerson efficiency plan

39. A worker, in the Halsey system of wage incentive plan, is—
    (A) Induced to do work
    (B) Ensured the minimum wages
    (C) Paid as per efficiency
    (D) Never a loser

40. Who are rewarded more in the Halsey 50-50 plan ?
    (A) Past average workers
    (B) Past poor workers
    (C) Past good workers
    (D) All of the above

41. In time study the basic unit of time measurement is—
    (A) 0·01 minute (B) 0·001 minute
    (C) 0·01 hour (D) 0·001 hour

42. The chart which is prepared in advance and shows sequence of parts to be processed is known as ..... chart
    (A) Man machine (B) Curve
    (C) Project layout (D) Load

43. developed the idea of functional organisation.
    (A) Gantt (B) F W. Taylor
    (C) Frank Gilberth (D) None of these

44. Which of the following is the basic tool of work study ?
    (A) Stop watch (B) Planning chart
    (C) Process chart (D) Graph paper

45. . .. is the large scale production carried out on special purpose machines.
    (A) Mass production
    (B) Batch production
    (C) Continuous production
    (D) Intermittent production

46. Micromotion study involves ..... fundamental hand motions
    (A) 12 (B) 16
    (C) 20 (D) 24

47 Therblig in micromotion study, is described by—
    (A) An event
    (B) Colours only
    (C) Standard symbol and colour
    (D) Symbols.

48. In work study, what does symbol ⇨ imply ?
    (A) Operation
    (B) Transport
    (C) Permanent storage
    (D) None of these

49. Human resource planning includes—
    (A) Raw material resources
    (B) Recruitment and selection
    (C) Sales of the firm
    (D) None of these

50 authored the principles of "scientific management".
    (A) Elton Mays (B) Henry Fayol
    (C) F W Taylor (D) M.P Follet

51 Queuing theory is used for—
    (A) Job shop scheduling
    (B) Inventory control
    (C) Traffic congestion studies
    (D) All of the above

52 was the first method invented for planning projects
    (A) CPM (B) PERT
    (C) Bar chart (D) Milestone chart

53 Management and administration means the same thing This opinion was given by—
    (A) Henry Fayol (B) F W. Taylor
    (C) Halsey (D) Spriegal

54. Bar charts are suitable for—
(A) Large projects (B) Major projects
(C) Minor projects (D) None of the above

55. Queuing theory is associated with—
(A) Inventory (B) Waiting time
(C) Sales (D) Production

56. ..... plan is not wage incentive plan.
(A) Halsey (B) Rowan
(C) Emerson (D) Taylor

57. Which of the following is the main disadvantage of line organisation ?
(A) Rigid structure
(B) Delays in communication
(C) Top level executives have to do excessive work
(D) All of the above

58. . . is used to find percent idle time for men or machines.
(A) Work study (B) Time study
(C) Method study (D) Work sampling

59 What does capital expenditure mean ?
(A) Expenditure on property
(B) Recurring expenditure
(C) Expenditure on procurement of fixed assests
(D) None of these

60 ..... is the times which results in least possible direct cost of an activity
(A) Standard time (B) Crash time
(C) Normal time (D) Slow time

61. With which of the following is 'Queuing theory' associated ?
(A) Production time (B) Inspection time
(C) Sales (D) Waiting time

62. With which of the following is simplex method the basic method ?
(A) Model analysis
(B) Linear programming
(C) Operating research
(D) Value analysis

63. .. .. plan ensures a part of the saving to the worker and rest to employer.
(A) Taylor
(B) Gilberth
(C) Emerson efficiency
(D) Halsey premium

64 In ..... the lines need to be balanced
(A) Plant layout
(B) Functional layout
(C) Process layout
(D) Product layout

65 ..... is the appellate authority for an industrial dispute
(A) President
(B) Labour court
(C) Management
(D) High court/Supreme court

66 A Gantt chart provides information about
(A) Production schedule
(B) Material handling
(C) Both (A) and (B)
(D) None of these

67 During ..... process inspection is carried out.
(A) Manufacture of the bolttles
(B) Surface grinding
(C) Surface hardening of mild steel plate
(D) Thread cutting on a lathe machine

68. Where is 'bin card' used—
(A) In workshop
(B) In assembly shop
(C) In administrative wing
(D) In stories

69 does not pertain to inventory management
(A) Effective running of store
(B) Control of stock
(C) Production schedule
(D) None of the above

70. The 'Employees Provident Fund Act' is applicable to—
(A) All major industries
(B) All industries
(C) The industries notified by government
(D) None of the above

71 ABC analysis deals with which of the following ?
(A) Controlling inventory costs money
(B) Flow of material
(C) Ordering schedule of job
(D) None of the above

72. Why is job enrichment technique' applied ?
    (A) To make people happy
    (B) To reduce labour monotony
    (C) To overcome boring and demotivating work
    (D) All of the above

73. ..... organisation is the best suited for steel plants.
    (A) Line
    (B) Staff
    (C) Line, staff, and functional
    (D) None of the above

74. In an automobile industry material handling is done by .....
    (A) Belt conveyon
    (B) Trolley
    (C) Overhead crane
    (D) None of the above

75. What does MIS stand for ?
    (A) Management information service
    (B) Management information system
    (C) Military inspection scheme
    (D) None of the above

76. In ..... production emergency rush order can be pushed more effectively
    (A) Automatic (B) Job
    (C) Intermittent (D) Continuous

77. A crater is a pit formed on—
    (A) Face of tool
    (B) Flank of tool
    (C) Surface of work piece
    (D) None of the above

78. A cutting tool fails due to—
    (A) Crater wear and flank wear
    (B) Crater formation
    (C) Crater wear and flank wear meeting to cause crumbling of cutting edge
    (D) None of the above

79 Swab is a—
    (A) Welding defect
    (B) Gear cutter
    (C) Tool used in foundry
    (D) Forging die

80. Planning and control departments normally do not consist of –
    (A) Inventory section
    (B) Printing section
    (C) Control cell
    (D) Quality section

81. The elasticity of demand explains the relationship between—
    (A) Price and demand
    (B) Utility and demand
    (C) Price of substitutes and utility
    (D) Income and demand

82. The retirement benefits for workman are covered under—
    (A) Payment of bonus act
    (B) Employees provident fund act
    (C) Workmen's compensation act
    (D) Payment of wages act

83. The price which covers the variable cost as well as the fixed price is—
    (A) Short term price
    (B) Market price
    (C) Long run price
    (D) Equilibrium price

84. The input-output analysis is often called as—
    (A) Value analysis
    (B) Cost benefit analysis
    (C) Non-pricing analysis
    (D) Inter industry analysis

85. Dispatching involves—
    (A) Starting the work
    (B) Collection data
    (C) Making plan correction
    (D) None of the above

86. Slack is—
    (A) Tolerance, in terms of time, for an activity
    (B) Earliest expected time-latest allowable time
    (C) Least available time-earliest expected time
    (D) Same as delay factor

87. Which of the following is not a job evaluation criteria ?
    (A) Classification
    (B) Ranking
    (C) Point rating
    (D) Needs of the worker

88. ABC analysis is used in—
    (A) PERT
    (B) CPM
    (C) Inventory control
    (D) All of the above

89. CPM is oriented to—
    (A) Time (B) Cost
    (C) Activity (D) Objective

90 Job going behind the schedule are conveniently shown in—
    (A) Pie chart (B) Bar chart
    (C) Milestone chart (D) Gantt chart

## Answers

| | | | | |
|---|---|---|---|---|
| 1 (C) | 2. (B) | 3. (D) | 4 (A) | 5. (A) |
| 6. (A) | 7. (A) | 8 (D) | 9 (B) | 10. (C) |
| 11. (B) | 12. (C) | 13 (C) | 14 (B) | 15. (C) |
| 16. (B) | 17. (D) | 18 (A) | 19 (B) | 20. (C) |
| 21. (D) | 22. (D) | 23. (C) | 24 (D) | 25. (B) |
| 26. (A) | 27. (C) | 28 (D) | 29 (D) | 30. (B) |
| 31. (D) | 32. (D) | 33. (D) | 34 (A) | 35. (C) |
| 36. (D) | 37. (C) | 38 (C) | 39 (B) | 40. (B) |
| 41. (B) | 42. (C) | 43. (B) | 44 (A) | 45 (A) |
| 46. (B) | 47. (C) | 48 (B) | 49 (B) | 50. (C) |
| 51. (C) | 52. (D) | 53. (A) | 54 (C) | 55. (B) |
| 56. (D) | 57. (D) | 58. (D) | 59 (C) | 60. (D) |
| 61. (D) | 62. (B) | 63. (D) | 64 (D) | 65. (D) |
| 66. (A) | 67 (C) | 68. (D) | 69 (C) | 70 (C) |
| 71. (A) | 72. (D) | 73. (C) | 74 (C) | 75. (B) |
| 76 (C) | 77. (A) | 78. (C) | 79. (C) | 80 (B) |
| 81. (A) | 82. (B) | 83. (C) | 84. (B) | 85. (A) |
| 86 (C) | 87. (D) | 88. (C) | 89 (C) | 90. (D) |

# 12 WORKSHOP TECHNOLOGY

## Foundry

A foundry is a place where castings are produced It is a section of the workshop where metal castings are produced, is known as the foundry or foundry shop

## Casting

The casting is a process of pouring molten metal into a mould and allowing it to solidify By this process, intricate parts can be given strength and rigidity which is not frequently obtainable by any other method. The mould or cavity into which the material is poured is made of some heat-resisting material Sand is widely used, as it can be readily packed to shape and resist high temperatures. Cast iron is widely used for casting This is due to the fact in casting with this metal, it is impossible to have easy control on its properties which include fluidity, rate of shrinkage, strength and rigidity. Cylinder blocks of airplane engine, piston rings, machine tool beds, water supply and sewer pipes, locomotive wheels are the examples of castings

## Foundry Tools & Equipments

A large number of tools and other equipment are used in foundry work, particularly in sand moulding, for carrying out different foundry operation. All of them can be broadly classified into the following categories—

1 Hand Tools
2 Moulding Boxes
3 Moulding Machines.
4 Melting Equipment
5 Pouring Equipment

**Hand Tools**—The common hand tools used in foundry work are the following—

(A) **Shovel**—It consists of an iron pan fitted with a wooden handle. It is used for mixing moulding sand for filling moulding sand into the flask

**Fig.** : Shovel

(B) **Hand Riddle**—It consists of a wooden frame fitted with a screen of standard wire mesh at its bottom It is used for removing foreign materials from the moulding sand

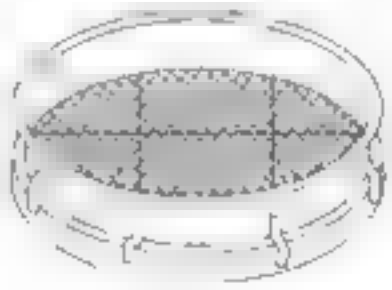


**Fig.** : Hand Riddle

(C) **Rammers**—This is used for striking the sand mass in the moulding box to pack it uniformly around the pattern. The common forms of rammers used in hand ramming are the following—

(1) *Hand Rammer* – It is smaller than the peen rammer and generally made of wood or metal On one end it carries a wedge type construction, called peen, and on the other a solid cylindrical shape, known as a butt. It is mainly used in bench moulding

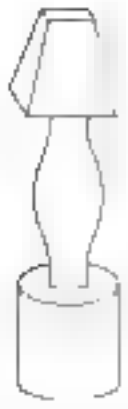


**Fig.:** Hand Rammer

(ii) *Peen Rammer*—It has a wedge-shaped construction formed at the bottom of a metallic rod. It is a common hand tool and is quite useful in packing the sand in pockets and corners.

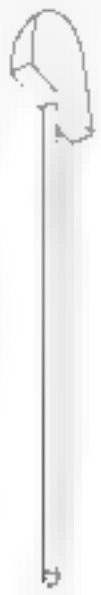


**Fig. :** Peen Rammer

(iii) *Floor Rammer*—It consists of a long steel bar carrying a peen at one end and a flat portion on the other It is a larger and heavier tool than the peen and hand rammer Its specific use is in floor moulding for ramming the sand in very large moulds Due to its large length the moulder can operate it in standing position

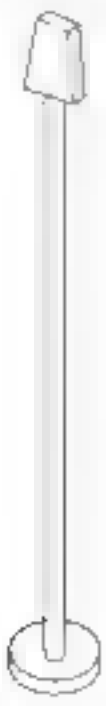


**Fig.:** Floor Rammer

(D) **Vent Wire**—It is a thin steel rod or wire carrying a pointed edge at one end and a wooden handle or a bent loop at the other. It is used to pierce holes in the rammed sand to provide artificial vents which permit the easy escape of steam and gases generated by the hot metal in contact with the sand

**Fig.:** Vent Wire

(E) **Strike off Bar**—It is a flat bar, made of wood or iron, to strike of the excess sand from the top of a box after ramming. Its one edge is made bevelled and the surface perfectly smooth and plane

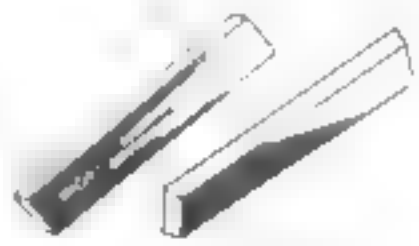


**Fig. :** Strike-off-bar

(F) **Slick**—It is a small double ended tool having one end flat and a spoon on the other They are used for preparing and finishing the mould surface and edges after the pattern has been withdrawn The commonly used slicks are heart and leaf, square and heart, spoon and bead and heart and spoon

**Fig. :** Slick

(G) **Smoothers and Corner Slicks**—They are also finishing tools used for repairing and finishing flat and round surfaces, round or square corners and edges Accordingly, they are given different names and the most common of these are shown above in the figure. These tools find a special favour in dry sand, green sand and loam sand work

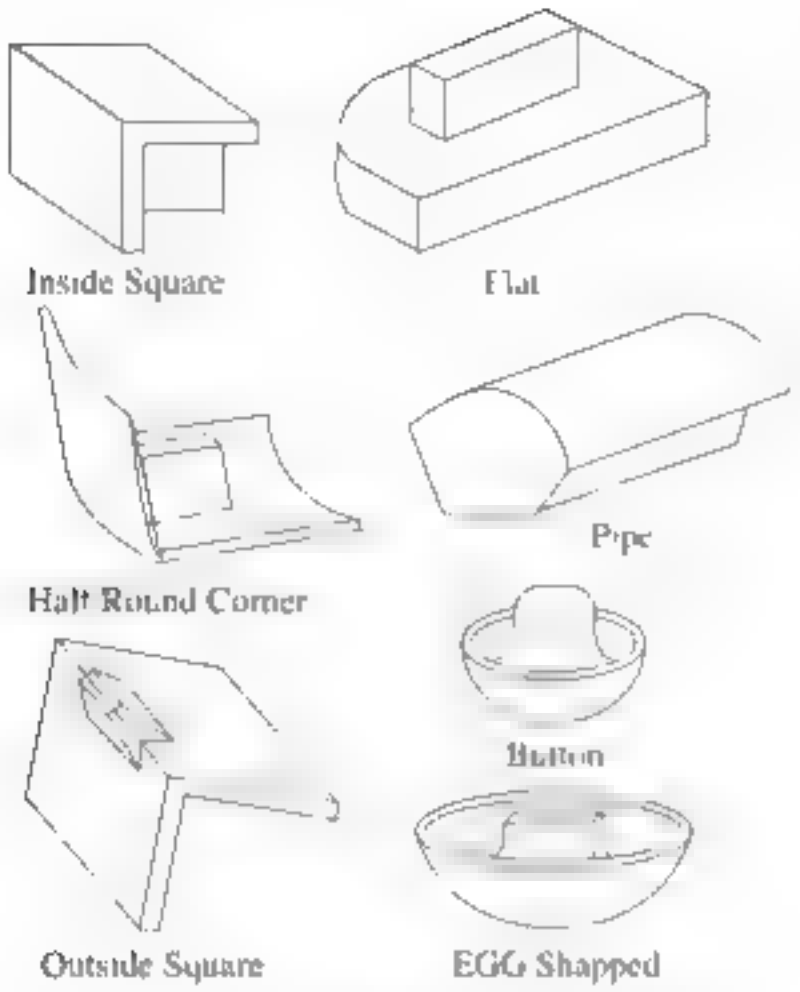



**Fig. :** Smoothers and Corner Sticks

(H) **Lifters or Cleaners**—It is also a finishing tool and is used for repairing and finishing the sand mould after withdrawal of pattern It is also used for removing loose sand from mould cavity Two useful forms of lifters are shown above in the figure

**Fig. :** A simple lifter or cleaner

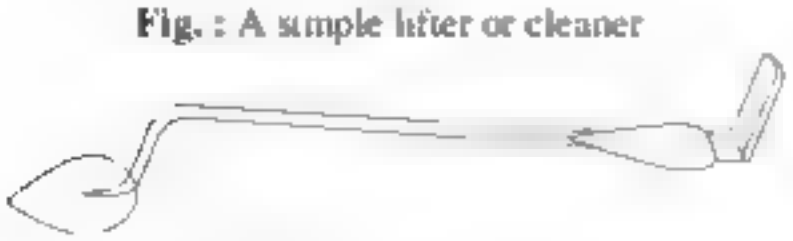


**Fig. :** A Yankee Lifter

(I) **Trowels**—A Trowel is used for smoothening the surfaces and joints in a mould They are made of iron and are provided with a wooden handle

**Fig. :** Trowels

(J) **Draw Spike**—It is a tapered steel rod having a loop or ring at its one end and a sharp point at the other. It is used for drawing patterns from the sand

**Fig. :** Draw spike

(K) **Mallet**—It is similar to a wooden mallet In foundry work it is used to loosen the pattern in the mould so that it can be withdrawn easily

**Fig. :** Mallet

(L) **Sprue Cutter**—A sprue cutter is also known as a runner peg. It is a tapered wooden peg. It is used to produce the hole after ramming the mould. It is in the form of tapered hollow tube which is inserted in the sand to produce the hole.

**Fig. :** Sprue Cutter

(M) **Sprue Pin**—It is a tapered rod of wood or iron which is embedded in the sand and later withdrawn to produce a hole, called runner, through which the molten metal is poured into the mould.

(N) **Gate Cutter**—It is a shaped piece of sheet metal to cut the feeding gate to connect the runner hole with the mould cavity.

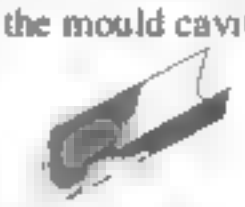


**Fig. :** Gate Cutter

(O) **Gaggers**—The gaggers are also known as lifters The gaggers are iron rods bent at one end or both ends It is used for reinforcement of sand in the top part of a moulding box and to support hanging bodies of sand Its lengths vary from 125 mm to 600 mm and it is coated with clay wash to cause the sand to adhere to them

**Fig. :** Gaggers

(P) **Bellow** – It is used to blow away the loose or unwanted sand from the surface and cavity of the mould

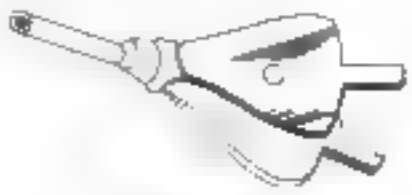
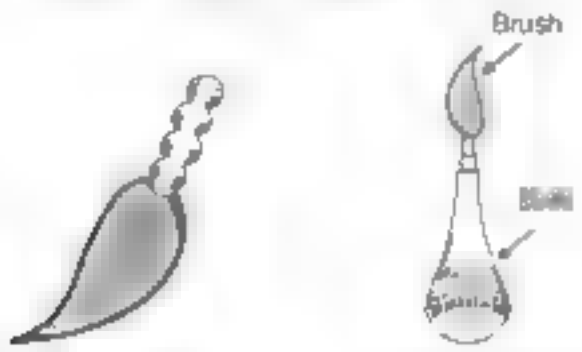


**Fig. :** Bellow

(Q) **Swab**—It is a hemp fibre brush used for moistening the edges of sand mould, which are in contact with the pattern surface, before withdrawing the pattern. A simple swab is a small brush having long hemp fibres. A bulb swab has a rubber bulb to hold the water and a soft hair brush at the open end It is used for moistening the sand around the edge before the pattern is removed




(a) Simple swab (b) Bulb swab

**Fig. :** Swabs

(R) **Rapping Plate**—It is made of sheet and are firmly fixed to the top of the pattern by screws or bolts. It is used for lifting and rapping large patterns It is available in different shapes

(S) **Spirit Level**—It consists of an air bubble in a curved glass tube protected by a wooden or metal flame It is used by the moulder to ensure that his bed of sand, moulding box or moulding machine table is horizontal

## Pattern

Patterns are the foundry man's mould forming tool It is used to form the mould cavity in which molten metal is poured Since it is a direct duplication, the pattern very closely conforms to the shape and size of the desired casting, except a few variations due to the necessary allowance.

### How a pattern differs from an actual component

(a) It carries additional projections to produce seats for cores

(b) To compensate for metal shrinkage, it carries an additional allowance

(c) It carries the necessary draft to enable its easy removal from the sand mass

(d) It carries additional allowances over those portions which are to be machined or finished otherwise

### Pattern Material

A pattern for multiple uses must last long. Therefore must be made from a suitable material The material commonly used for pattern making includes wood, metal and alloys, plasters, plastic, rubber and wax

### Material Selection for Making a Pattern

(a) It should be easily shaped, worked, machined and joined

(b) It should be resistant to wear and corrosion

(c) It should be resistant to chemical action

(d) It should be easily available and economical

(e) It should be dimensionally stable and must remain unaffected by variations in temperature and humidity

### Characteristic Pattern Material

(A) **Wood**—The most commonly used pattern material is dried or seasoned wood The most important reason for using wood for making pattern is its easy availability, low weight, and low cost. It can be easily shaped, worked, joined and is relatively cheap By a rough estimate, more than 90% of the casting are produced using wooden pattern The main disadvantage of the wood is that it absorbs moisture, because of which distortions and dimensional changes occur For very large castings, wood may be the only practical pattern material

(B) **Metal**—Metal patterns are extensively used for the large quantity production of castings and for closer dimensional tolerances on castings It has much longer life and are free from major disadvantages of wooden patterns. The metal used for pattern material are aluminium, iron and brass. Aluminium is most commonly used

(C) **Plastic**—Plastics are used as pattern material because of their low weight, easier formability, smooth surfaces, and durability. Phenolic resin plastic and foam plastic suit best for this purpose. For making the pattern first the moulds are made, usually from plaster of Paris. The resin is then poured into these moulds and the two heated. At a specific temperature the resin solidifies to give the plastic pattern.

(D) **Polystyrene**—Polystyrene or expanded thermocole is another pattern material, which has the special property that it changes to gaseous state on heating. Pattern made from polystyrene are disposable patterns, that are suitable for single casting, like a prototype. It is very easy to make a pattern from polystyrene because it is soft.

(E) **Wax**—These patterns are exclusively used in investment casting. For this a die or metal mould is made in two halves into which the heated wax is poured. The die is kept cool by circulating water around it. As the wax sets on cooling the die parts are separated and the wax pattern taken out.

## Pattern Contraction Allowances for Different Materials

| Metal | Allowances mm/metre |
|---|---|
| Cast iron (Grey) | 10·5 |
| Cast iron (White) | 21·5 |
| Aluminium | 16·0 |
| Malleable iron | 10·5 |
| Brass | 16·0 |
| Bronze | 10·5–21·0 |
| Silver | 10·0 |
| Lead | 24·0 |
| Tin | 7·0 |
| Zinc | 24·0 |
| Copper, Nickel, Magnesium | 16·0 |
| Steel | 21·0 |

## Master Pattern

It is used for preparing the moulds for metal castings which are later used as pattern for further moulding work. It is accurately finished wooden pattern which carries double shrinkage allowance and the required machining allowance. For example, an aluminium pattern is to be made which is to be used for making mould for brass castings.

Size of master pattern = Size of the final casting to be made+shrinkage allowance for the material of which the pattern is to be made + finishing allowance for the metal pattern.

## Machining Allowance

Machining allowance or finishing allowance is the extra material added to the certain parts of the casting to enable their machining or finishing to the required size, accuracy and surface finish. Thus this allowance is provided on those surfaces which are not to be left as cast but are to be subjected to one or more machining operations like turning and shaping. The amount of this allowance varies from 1·6 mm to 12·5 mm which depends upon the casting method used, size and shape of the casting, type of material, machining process to be used, degree of accuracy and surface finish required.

## Draft Allowance or Taper Allowance

It is a taper provided on vertical faces of the removable patterns so that the pattern can be withdrawn from the rammed sand without causing damage to the vertical sides and without the need for excessive rapping. The amount of draft varies from 10 mm to 25 mm per metre on external surfaces and from 40 mm to 70 mm per metre on internal surfaces.

## Shake Allowance or Rapping Allowance

This allowance is important in large-sized or precision castings. When a pattern is rapped for easy withdrawals, the mould cavity is enlarged. To account for this increase in size of cavity, the pattern size is reduced, *i.e.*, the pattern is made smaller by an amount equal to the mould enlargement that may take place during rapping. The amount of rapping allowance depends upon factors such as extent of rapping, size of mould, degree of compaction of sand, most of these are difficult to evaluate.

## Functions of Pattern

The principal functions of a pattern are as under –

1. To produce seats for cores in the mould The seats in the mould are called coreprints.
2. To minimise defects in casting
3. To establish the parting surface and lines in the mould
4. To produce the mould cavity of appropriate shape and size in which the molten metal can be poured to obtain desired casting
5. To enable production of greesand or rammed-up cores within the mould itself
6. To minimise the cost of casting
7. To establish distinct locating points in the moulds

## Types of Pattern

The type of pattern used for a particular casting depends upon the following factors—

1. The bulk of casting
2. The number of casting required.
3. Type of moulding process
4. The shape and size of casting.

The following common types of pattern are used—

**1. Solid or Single Piece Pattern**—This type of pattern is the simplest of all the patterns It depends upon the shape and it can be moulded in one or two boxes This type of pattern is used for a limited number of castings because most of the moulding operations like parting surface formation, cutting of gating system, providing runners and risers, withdrawal of pattern etc is done by hand. The figure as shown below is the solid pattern

**Fig.** : Solid or single piece pattern

**2. Split or Two Piece Pattern**—If a solid pattern is used, many times the design of casting offers difficulty in mould making and withdrawal of pattern Hence for such castings split or two piece patterns are employed. The split in the pattern occurs at the parting line of the mould. The two parts are alligned by means of Dowel pins as shown in the figure. In case of complicated castings, a pattern may be made in three or more parts. Such patterns are known as multi-piece pattern

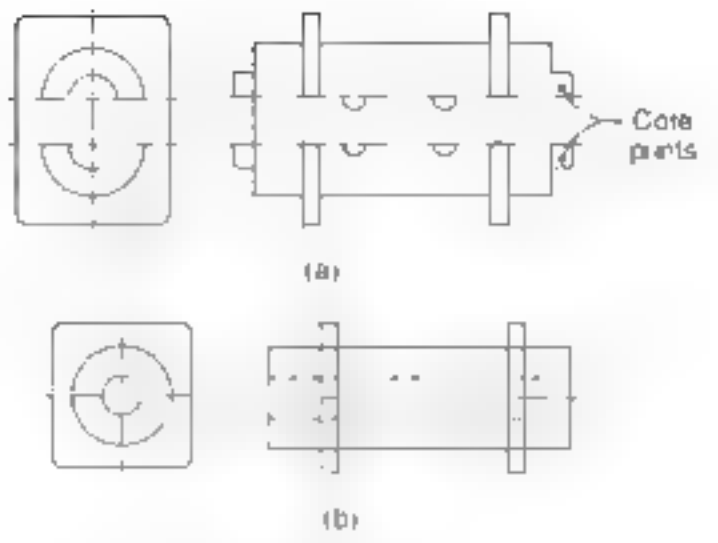



**Fig.** : A split pattern

(a) Two halves of pattern, (b) Prepared casting

The split patterns are commonly used for casting of spindles, cylinders, steam valve bodies, water stop-cocks and taps, bearings, wheels and small pulleys

**3. Gated Pattern**—Generally gated patterns are made of metal to make them strong. They are used in mass production of small castings. For such castings multi-cavity moulds are prepared *i.e.*, a single sand mould carries a number of cavities as shown in fig. For small production, these patterns may be made of wood, but for large production metallic patterns are preferred

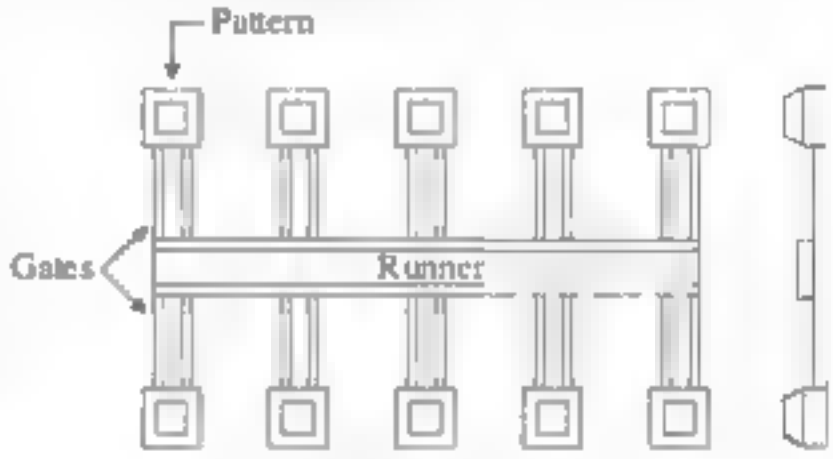
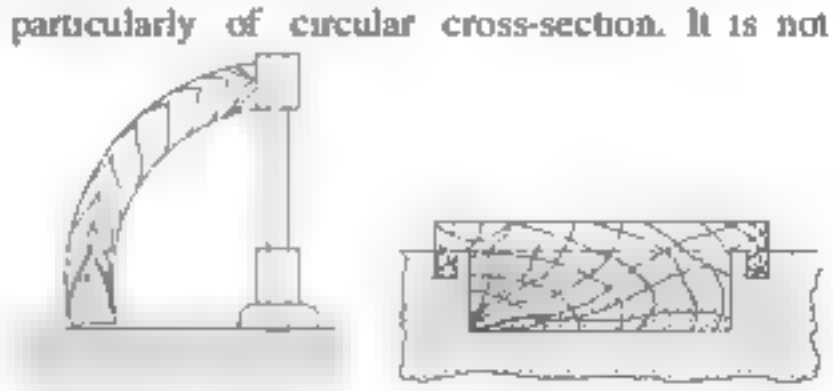



**Fig.** : Gated Pattern

**4. Sweep Pattern**—This pattern is used for preparing moulds of large symmetrical castings, particularly of circular cross-section. It is not



(a) Curved sweep (b) Straight sweep

**Fig.** : Sweep Pattern

considered as a true pattern when compared with other. A sweep is a template of wood or other material which has the shape corresponding to the shape and size of castings The principal advantage of this pattern is that it eliminates expensive pattern construction

**5. Skeleton Pattern** – When a few and large-sized castings are required, it is not suggestable to use a large solid pattern of that size because it will require a lot of wood and time to make a full pattern. In such condition, a skeleton pattern in the hollow form, wooden frame and stripes is used as shown in the fig It is filled with loam sand and rammed. The surplus sand is removed by means of a strickle

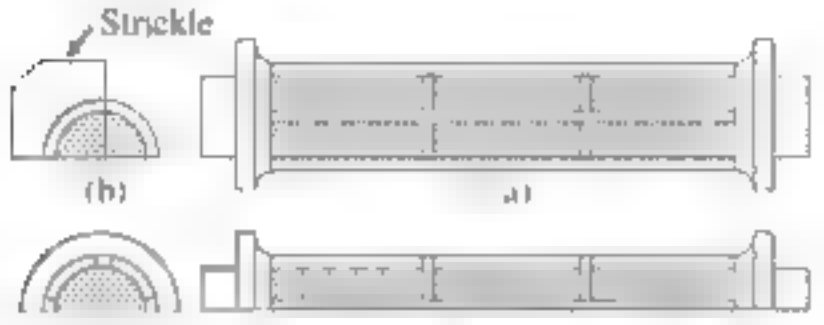



**Fig.:** Skeleton Pattern

**6. Shell Pattern**—It is used largely for drainage fittings and pipe work Shell pattern is usually made of metal mounted on a plate and parted along the centre line, the two sections being accurately doweled together The short bends are usually moulded and cast in pairs. Shell pattern is a hollow construction like a shell Its outside shape is used as a pattern to make mould while its inside is used as a core box for making cores

**7. Cope and Drag Pattern**—When a large castings are to be made, the whole pattern becomes too heavy to be handled by a single operator In that condition a pattern is made in two parts which are separately moulded in different moulding boxes. When the moulds are completed, the two boxes are assembled to form the complete cavity, of which one part is contained by the drag and the other in cope

**8. Loose Piece Pattern**—It is a pattern with loose pieces, which are necessary to facilitate withdrawal of the pattern from the mould. This type of pattern is used when the contour of the part is such that withdrawal of the pattern from the mould is not possible. This type of pattern is also used in such condition where the castings is having projections, undercuts or other configurations that would otherwise hinder the removal of the pattern Hence, during moulding the obstructing part of the contour is held as a loose piece by the wire

**9. Match Plate Pattern** – When the split patterns are attached on either side of the match plate, it called match plate pattern A match plate is a plate on which two halves of a split pattern are mounted, on either side, such that one side is used to prepare one flask and the other side is used to prepare other flask Match plate patterns speed up production and help in maintaining uniformity in the size and shape of the castings

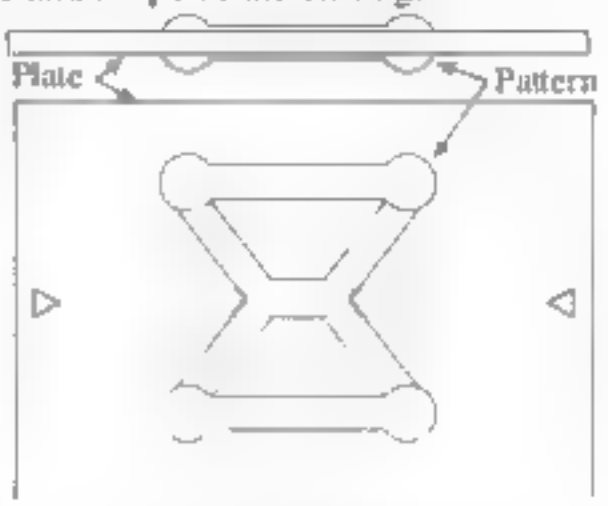



**Fig.:** Match plate patern

## Defects in Casting

The defects in a casting may be due to pattern and moulding box equipment, moulding sand, cores, gating system or molten metal The principal defects are as under—

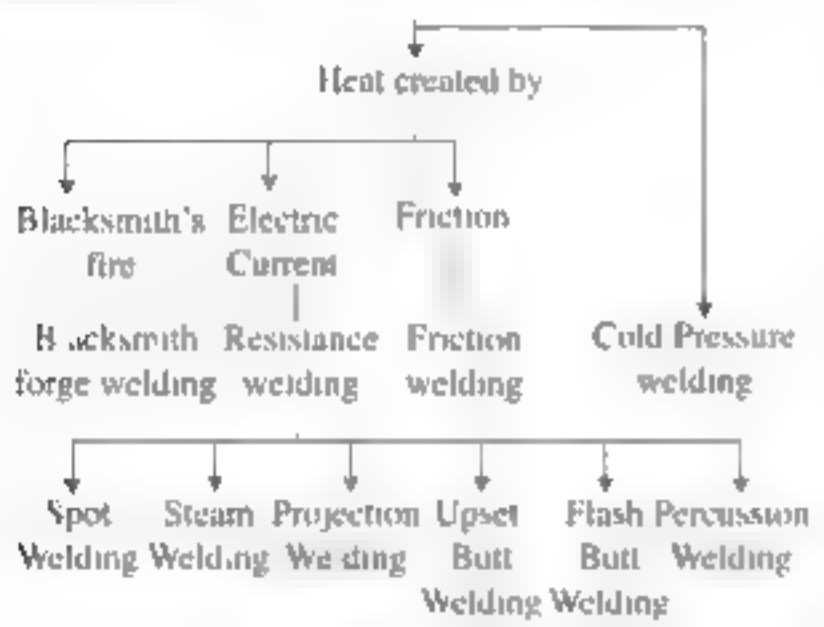
1. **Swell**—It is an enlargement of the mould cavity by molten metal pressure resulting in localised or general enlargement of the casting
2. **Shrinkage**—It is a crack in the casting or dishing on the surface of a casting which results from unequal contraction of the metal during solidification.
3. **Pour Short**—It occurs when the mould cavity is not completely filled because of insufficient metal
4. **Scabs**—It is the patch of sand on the upper surface of the casting
5. **Mould Shift**—It results in a mismatching of the top and bottom parts of a casting, usually at the parting line.
6. **Sand Wash**—It usually occurs near the ingates as rough lumps on the surface of a casting
7. **Fins and Flash** – It is the thin projection of metal not intended as a part of casting These usually occur at the parting line of the mould.
8. **Sand Blow or Blow Hole** · It is an excessively smooth depression on the outer surface of a casting

9. **Slag Holes** – These are smooth depression on the upper surface of the casting. They usually occur near the ingates

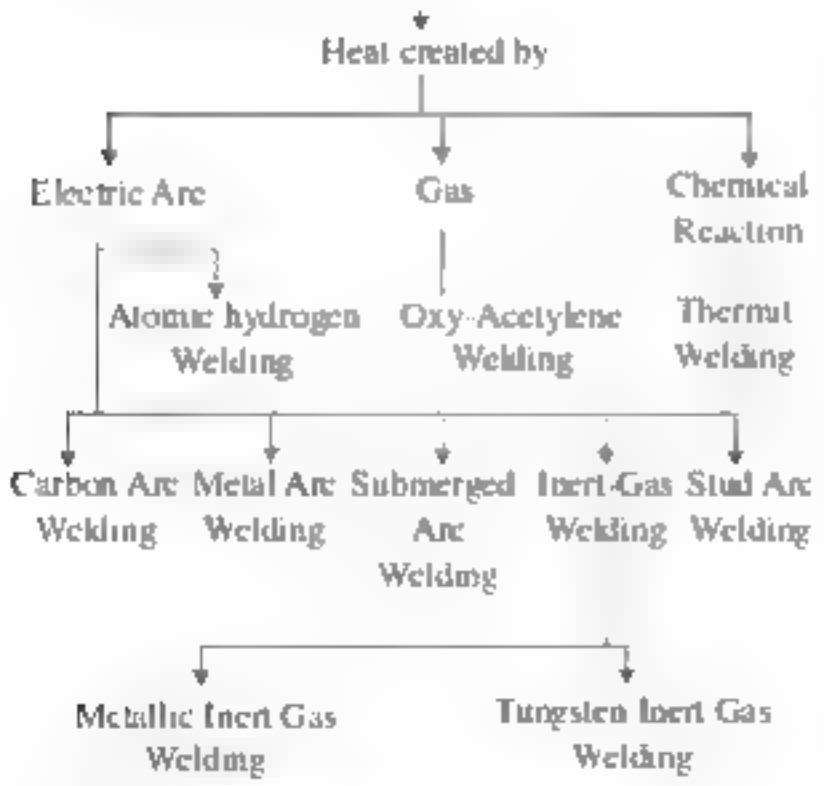
## Welding

It is a process of joining two similar or dissimilar metals by fusion, with or without the application of pressure and with or without the use of filler metal. The welding is broadly divided into the following two groups

**1. Pressure or Forge Welding (without any filler metal)**




**2. Non-pressure or Fusion Welding (without any filler metal)**




## Types of Welded Joints

Lap joint, Butt joint, Corner joint, Edge joint and T joints are the commonly used joints in fusion welding

The lap joints are employed on plates having thickness less than 3 mm In butt welds, the edges do not require bevelling if the thickness of plate is less than 5 mm If the plate thickness is 5 mm to 12 5 mm, the edges should be bevelled to V or U-groove and plates having thickness above 12 5 mm should have a V or U-groove on both sides

## Electric Resistance Welding

It is used for joining pieces of sheet metal or wire It is a type of pressure welding. The welding heat is obtained at the location of the desired weld by the electrical resistance through the metal pieces to a relatively short duration, low voltage (from 6 to 10 volts only) high amperes (varying from 60 to 4000 amperes) electric current. The amount of current can be regulated by changing the primary turns of the transformer. When the area to be welded is sufficiently heated, the pressure varying from 25 to 55 MPa is applied to the joining area by suitable electrodes until the weld is solid The various types of electric resistance welding are as follows—

**1. Spot Welding**—It is used for welding lap joints, joining components made from plate material having 0·025 mm to 1·25 mm in thickness. The plate to be joined together are placed between the two electrode tips of copper or copper alloy The electrode tip diameter ($d$) should be equal to $\sqrt{t}$, where '$t$' is the thickness of plate and the distance between the nearest edge of plate and centre of weld should be at least 1·5 $d$ The spacing between two spot welds should not be less than $3d$

**2. Projection Welding**—It is similar to spot welding except that one of the metal pieces to be welded has projection on its surface at the points where the welds are to be made In other words, it is a multi-spot welding process

**3. Butt Welding**—It is of mainly two types *i.e.*, flash butt welding and upset butt welding The upset butt welding is especially adopted to rods, pipes and many other parts of uniform section. The flash butt welding is extensively used in the manufacture of steel containers and in the welding of mild steel shanks to high speed drills and reamers

**4. Arc Welding** - The arc welding is a fusion welding process in which the welding heat is obtained from an electric arc struck between the work and an electrode The temperature of heat

produced by the electric arc is of the order of 6000°C to 7000°C. Both the direct current (D.C.) and alternating current (A.C.) may be used for arc welding, but the direct current is preferred for most purposes. Following are the two types of arc welding depending upon the type of electrode—

(A) When a large electrode or filler rod is used for welding, it is said to be unshielded arc welding.

(B) When the welding rods coated with fluxing material are used, then it is said to be shielded arc welding.

**5. Carbon Arc Welding**—In carbon arc welding the welding heat is obtained from an electric arc between a carbon electrode and the work. In welding heavy plates, the additional metal is deposited in the weld from a filler rod.

**6. Metal Arc Welding**—In metal arc welding the arc is produced between the metal electrode (filler rod) and the workpiece. During the welding process, the metal electrode is melted by the heat of the arc and fused with the work piece. The temperature produced by the heat is about 2400°C to 2700°C.

**7. Atomic Hydrogen Welding**—In atomic hydrogen welding, the arc is obtained between two tungsten electrodes while a stream of hydrogen passes by the arc and envelops the welding zones.

**8. Stud Arc Welding**—It is direct current arc welding process and it is used for welding metal Studs to the flat metal surfuces

**9. Submerged Arc Welding**—In submerged arc welding, the arc is produced between a bare metal electrode and the work piece. The submerged arc welding is mostly done on low carbon and alloy steel but it may be used on many of the non-ferrous metals

**10. Thermit Welding**—A mixture of iron oxide and aluminium is used in thermit welding The mixture is ignited only at a temperature of about 1500°C. The major advantage of the thermit welding is that all parts of the weld section are molten at the same time and the weld cools almost uniformly. This results in a minimum problem with internal residual stresses. The thermit welding is often used in joining iron and steel parts that are too large to be manufactured such as rails, truck frames, locomotive frames, rail roads, for stern frames, rubber frames etc.

**11. Gas Welding** - It is a type of fusion welding in which the heat for welding is obtained by the combustion of a fuel gas. The most widely used gas combination for producing a hot flame for welding metals is oxygen and acetylene ($C_2H_2$) The approximate flame temperature produced by oxy-acetylene flame is 3200°C.

**Die and Punch**—A die is a female part of a complete tool for producing work in a press. A punch is a male component of the die assembly, which is directly or indirectly moved by the press ram.

**Bench Work and Fitting**—The work carried out by hand at the bench is called bench work whereas fitting is the assembling of parts together by filing, chipping, sawing, scraping, tapping etc. necessary after the machine operation. The various tools used in fitting practice are as follows—

**1. Cutting Tools**—The chief cutting tools used in fitting are cold chisels, hacksaws and files.

(a) **Cold Chisels**—These are used to cut cold metal and are made by forging from cast tool steel of octagonal cross-section. After forging to shape and roughly grinding, the cutting edge should be hardened and tempered. The most commonly used cutting angle is 60° but this varies according to the type of material cut.

(b) **Hacksaws**—It is the chief tool used by the fitter for cutting rods, bars and pipes into desired lengths. The cutting blade of hacksaw are made of carbon or high speed steel. The blades are specified by its length and the point or pitch. The point or pitch is measured by number of teeth per 25 mm length. The points of the teeth are bent to cut a wide groove and prevents the body of the blade from rubbing or jamming in the saw cut. This bending of the teeth to the sides is called the setting of the teeth Usually alternate teeth are set to right and left, every third or fifth tooth left straight to break up the chips and help the teeth to clear themselves

(c) **Files**—A file is a hardened piece of high grade steel with slanting rows of teeth It is used to cut, smooth or fit metal parts. The size of the file is indicated by its length. The coarseness or pitch of the file varies directly as the length of the file Hence larger the length of the file coarser will be the pitch and smaller the file, finer will be the pitch.

## Measuring Instruments and Gauges

**1 Ring Gauge**—It is used to check the diameter of shafts or studs.

2. **Plug Gauge**– It is used to test the accuracy of holes. The standard plug gauge is used in general engineering workshop, tool room etc. The limit plug gauge is used where large quantities are to be produced. The single ended limit plug gauge has separate 'Go' and 'Not go' members. The progressive limit plug gauge has 'Go' and 'Not go' members on the same side of a handle

3. **Snap Gauge**—It is used to check the external dimension

4. **Slip Gauge**—It is used to check the accuracy of micrometers, callipers, snap gauge, dial indicators etc.

5. **Feeler Gauge**—It is used to check the clearances between two mating surfaces.

6. **Outside Micrometer**—It is mainly used to measure outside diameter of a job or length of a small part to an accuracy of 0·01 mm.

7. **Inside Micrometer**—It is used to measure large internal diameters (over 50 mm) to an accuracy of 0·01 mm.

8 **Screw Thread Micrometer**—It is used to measure the pitch diameter of screw threads to an accuracy of 0·01 mm.

9. **Depth Gauge Micrometer**—It is used to measure the depth of holes, slots and recessed areas to an accuracy of 0·01 mm

10. **Vernier Callipers**—It is used to measure external as well as internal diameters of shafts, thickness of parts, depth of slots and holes to an accuracy of 0·02 mm

11. **Vernier Height Gauge**—It is mainly used to measure heights of parts to an accuracy of [illegible].

12. **Vernier Depth Gauge**—It is used to measure the depth of holes, recesses, and distances from plane surface to a projection, to an accuracy of 0·02 mm

13. **Sine Bar**—It is used either to measure angles more precisely than a bevel protractor or for locating any work to a given angle within very close limits. It is generally used with slip gauges.

14. **Combination Set**—It is very much useful instrument and has all the essential features of try square, bevel protractor, rule and scriber.

15. **Universal Bevel Protractor**—It is also called vernier bevel protractor. It is used for measuring and testing angles, within the limits of 5 minutes ($\frac{1}{12}$ of a degree).

## OBJECTIVE QUESTIONS

1. The casting method adopted for ornaments and toys of non-ferrous alloys, is—
   (A) Slush casting
   (B) Die casting
   (C) Permanent mould casting
   (D) Centrifugal casting

2. In hot chamber die casting machine—
   (A) Melting pot is an integral part of the machine
   (B) Melting pot is separate from the machine
   (C) High temperature and pressure is used
   (D) Melting pot have any location

3. Scabs are casting defects which—
   (A) Occur near the ingates as rough lumps on the surface of a casting
   (B) Occur as sand patches on the upper surface of a casting
   (C) Result in a mismatching of the top and bottom parts of a casting
   (D) Result in general enlargement of the casting

4. Cast iron and steel pipes are produced by—
   (A) Die casting
   (B) Slush casting
   (C) Investment casting
   (D) True centrifugal casting

5. A casting defect which occurs near the ingates as rough lumps on the surface of a casting is known as—
   (A) Swell (B) Scab
   (C) Shift (D) Sand wash

6. A casting defect which results in general enlargement of a casting is known as—
   (A) Sand wash (B) Swell
   (C) Shift (D) Blow hole

7. Swab is used for—
   (A) Repairing and finishing the mould
   (B) Smoothing and cleaning out depression in the mould

(C) Reinforcement of sand in the top part of moulding box
(D) Moistening the sand around the edge before removing pattern

8. In order to deliver molten metal from pouring basin to gate—
(A) A core is used (B) A riser is used
(C) A sprue is used (D) A gagger is used

9. Which of the following statement is wrong ?
(A) A gagger is used for cleaning the moulding sand
(B) A slick is used for repairing and finishing the mould
(C) A stripper-plate machine is used to draw the pattern from the mould
(D) None of the above

10. When a pattern is made in three parts, the top part is known as—
(A) Check (B) Cope
(C) Drag (D) None of the above

11. The surface to be machined is marked on the pattern by—
(A) Yellow colour (B) Black colour
(C) Red colour (D) Blue colour

12 The surface to be left unmachined is marked on the pattern by—
(A) Blue colour (B) Yellow colour
(C) Red colour (D) Black colour

13 A taper provided on the pattern for its easy and clean withdrawal from the mould is known as—
(A) Draft allowance
(B) Machining allowance
(C) Distortion allowance
(D) Shrinkage allowance

14. The adhesiveness is the property of a sand due to which—
(A) The sand grains stick together
(B) It evolves a great amount of steam and other gases
(C) It clings to the sides of a moulding box
(D) None of the above

15. If an aluminium pattern made from wooden master pattern is to be used for grey iron castings, then the shrinkage allowance on the wooden pattern should be—
(A) 12 mm/m (B) 16 mm/m
(C) 22 mm/m (D) 26 mm/m

16. In centrifugal casting method –
(A) Core is made of non-ferrous metal
(B) Core is made of sand
(C) Core is made of ferrous metal
(D) No core is used

The purpose of riser is to—
(A) Act as a reservoir for the molten metal
(B) Deliver molten metal into the mould cavity
(C) Deliver molten metal from pouring basin to gate
(D) Feed the molten metal to the casting in order to compensate for the shrinkage

18 Cores are used to—
(A) Improve mould surface
(B) Form a part of a green sand mould
(C) Form internal cavities in the casting
(D) All of the above

19 The purpose of a gate is to—
(A) Act as a reservoir for the molten metal
(B) Deliver molten metal into the mould cavity
(C) Deliver molten metal from pouring basin to gate
(D) Feed the molten metal to the casting in order to compensate for the shrinkage

20. Green sand is a mixture of—
(A) 30% sand and 70% clay
(B) 90% sand and 10% clay
(C) 50% sand and 50% clay
(D) 70% sand and 30% clay

21 The sand used for making cores is—
(A) Loam sand (B) Oil sand
(C) Dry sand (D) Green sand

22. Recrystallisation temperature of steel is—
(A) 450°C (B) 650°C
(C) 700°C (D) 800°C

23. The hot working of metals is carried out—
(A) Below the recrystallisation temperature
(B) Above the recrystallisation temperature
(C) At the recrystallisation temperature
(D) At any temperature

24. During hot working of metals—
(A) Scale is formed on the metal surface
(B) Poor surface finish is produced
(C) Close tolerances cannot be maintained
(D) All of the above

25. Cold working of metals is carried out –
(A) Below the recrystallisation temperature
(B) Above the recrystallisation temperature
(C) At the recrystallisation temperature
(D) At any temperature

26. The increase in hardness due to cold working, is called –
(A) Flame hardening
(B) Work hardening
(C) Age hardening
(D) Induction hardening

27. Cold working of metal increases –
(A) Hardness (B) Tensile strength
(C) Yield strength (D) All of the above

28. During cold working process–
(A) Close dimensional tolerance can be maintained
(B) Grain structure is distorted
(C) Strength and hardness of metal increases
(D) All of the above

29 The process extensively used for making bolts and nuts is –
(A) Cold peening (B) Cold heading
(C) Hot piercing (D) Extrusion

30 A moving mandrel is used in –
(A) Tube drawing (B) Forging
(C) Wire drawing (D) Metal Cutting

31. The dowels are –
(A) Box nails (B) Wire nails
(C) Wooden nails (D) None of these

32 A mortise gauge is a –
(A) Planing tool (B) Boring tool
(C) Marking tool (D) Striking tool

33. Thread rolling is restricted to–
(A) Hard materials (B) Ferrous materials
(C) Ductile materials (D) None of these

34. A rip saw–
(A) Is a two man saw
(B) Is used for cutting along the grains of wood
(C) Has a narrow blade with two wooden handles
(D) All of the above

35 Aluminium is the best material for making patterns because it is–
(A) Corrosion resistant
(B) Easy to work
(C) Light in weight
(D) All of the above

36 For smoothening and cleaning out depressions in the mould, a.....is used
(A) Lifter (B) Swab
(C) Gagger (D) Slick

37 In order to produce uniform packing of sand in the moulds, a.....is used
(A) Jolt machine
(B) Sand slinger
(C) Stripper plate machine
(D) Squeezing machine

38 The property of sand due to which the sand grains stick together, is called–
(A) Permeability (B) Cohesiveness
(C) Adhesiveness (D) Collapsibility

39. Which one of the following material will require the largest size of riser for the same size of casting ?
(A) Cast iron (B) Steel
(C) Copper (D) Aluminium

40. The tolerance produced by shell moulding process of casting is–
(A) ± 0·5 mm (B) ± 0·2 mm
(C) ± 1 mm (D) ± 0·05 mm

41 In average work, the tolerance produced by investment casting method is–
(A) ± 0·5 mm (B) ± 0·2 mm
(C) ± 0·005 mm (D) ± 0·05 mm

42 The fullers are used–
(A) For punching a hole
(B) To finish the punched hole
(C) For necking down a piece of work
(D) For finishing flat surfaces

43. The operation of cutting of a flat sheet to the desired shape is called–
(A) Punching (B) Piercing
(C) Blanking (D) Shearing

44. The operation of bending a sheet of metal along a curved axis, is known as–
(A) Notching (B) Slitting
(C) Forming (D) Plunging

45. The operation of straightening a curved sheet metal, is known as–
(A) Squeezing (B) Coining
(C) Planishing (D) Drawing

46. In piercing operation, the clearance is provided on –
(A) Die
(B) Punch
(C) Half on the punch or die depending upon designer's choice
(D) Half on the punch and half on the die

47. In spot welding, the spacing between two spot weld should not be less than—
(A) $d$ (B) $1.5d$
(C) $3d$ (D) $6d$

48. The electrode tip diameter ($d$) in spot welding should be equal to—
(A) $\sqrt{t}$ (B) $1{\cdot}5\sqrt{t}$
(C) $3\sqrt{t}$ (D) $6\sqrt{t}$

49. In arc welding, the electric arc is produced between the work and the electrode by—
(A) Flow of current (B) Contact resistance
(C) Voltage (D) All of these

50 For arc welding—
(A) Direct current is used
(B) Alternating current with high frequency is used
(C) Alternating current with low frequency is used
(D) None of these

51 In electric resistance welding, voltage required for heating is—
(A) 2 to 4 volts (B) 6 to 10 volts
(C) 12 to 16 volts (D) 60 to 90 volts

52. Spot welding is used for welding—
(A) Lap joints in plates having 0·025 to 1·25 mm thickness
(B) Lap joints in plates having thickness above 4 mm
(C) Butt joints in plates having 0·025 mm to 5 mm thickness
(D) Butt joints in plates having thickness above 5 mm

53. In shielded arc welding—
(A) Welding rod coated with slag is used
(B) Large electrode is used
(C) Welding rod coated with fluxing material is used
(D) None of the above

54 Seam welding is a—
(A) Continuous spot welding process
(B) Multi-spot welding process
(C) Arc welding process
(D) Process used for joining round bars

55 The flux commonly used in brazing is—
(A) Borax
(B) Zinc chloride
(C) Ammonium chloride
(D) Rosin plus alcohol

56. Carburising flame is used to weld—
(A) Brass and bronze
(B) Hard surfacing materials such as a stellite
(C) Steel, cast iron, copper, aluminium etc.
(D) All of the above

57 A neutral flame is obtained by supplying—
(A) More volume of oxygen and less volume of acetylene
(B) Equal volumes of oxygen and acetylene
(C) More volume of acetylene and less volume of oxygen
(D) None of the above

58. Most of the oxy-acetylene welding is done with—
(A) Oxidising flame (B) Carburising flame
(C) Neutral flame (D) All of the above

59. The maximum flame temperature occurs—
(A) At the inner core
(B) At the outer core
(C) At the torch tip
(D) Between the outer and inner core

60. In thermit welding, thermit is a mixture of—
(A) Charcoal and aluminium
(B) Iron oxide and aluminium
(C) Charcoal and iron oxide
(D) Charcoal, iron oxide and aluminium

61 The consumable electrode is used in—
(A) Submerged arc welding
(B) Carbon arc welding
(C) MIG arc welding
(D) TIG arc welding

62. In fore-hand welding, the weld is made—
(A) From right to left
(B) From left to right
(C) Either from left to right or from right to left
(D) First from left to right and then from right to left

63. In arc welding, the electric arc is produced between the work and the electrode by—
(A) Flow of current (B) Contact resistance
(C) Voltage (D) All of the above

64. The welding process used in joining mild steel shanks to high speed drills, is—
(A) Seam welding
(B) Spot welding
(C) Flash butt welding
(D) None of the above

65. In TIG arc welding, the welding zone is shielded by an atmosphere of—
(A) Hydrogen gas (B) Oxygen gas
(C) Either (A) or (B) (D) Helium gas

66. The cold chisel is made by—
(A) Forging (B) Drawing
(C) Rolling (D) Piercing

67. The cold chisels are made from—
(A) Mild steel (B) High speed steel
(C) Cast tool steel (D) Stainless steel

68. The cross section of chisel is usually—
(A) Square (B) Octagonal
(C) Hexagonal (D) Rectangular

69. The hacksaw blade cuts on the—
(A) Return stroke
(B) Forward stroke
(C) Cutting depends upon the direction of force
(D) Both forward and return strokes

70 A hacksaw blade is specified by its—
(A) Width (B) Number of teeth
(C) Material (D) Length

71 The teeth of hacksaw blade are bent—
(A) Towards left
(B) May be bent in any direction
(C) Towards right
(D) Alternately towards right and left and every third or fourth left straight

72. A file with 20 teeth in 25 mm is called—
(A) Smooth file
(B) Rough file
(C) Dead smooth file
(D) Bastard file

73 The type of file used for a wood work is—
(A) Rasp-cut file (B) Double cut file
(C) Single-cut file (D) None of these

A file removes the metal during—
(A) Return stroke
(B) Forward stroke
(C) Both (A) and (B)
(D) None of the above

75 V-block is used to—
(A) Locate centres of round rods
(B) Check the surface roughness
(C) Check the trueness of flat surface
(D) None of these

76 A sheet metal pattern is—
(A) A full size drawing of the object
(B) A three dimensonal drawing of the object
(C) An isometric drawing of the object
(D) None of these

77. When the dimensions is expressed as $20^{+0.035}_{-0.025}$, then the tolerance is—
(A) 0·15 mm (B) 0·20 mm
(C) 0·025 mm (D) 0·02 mm

78 The instrument used to measure external and internal diameter of shafts, thickness of parts and depth of holes, is—
(A) Inside micrometer
(B) Outside micrometer
(C) Vernier Callipers
(D) Depth gauge micrometer

79. The accuracy of micrometers, callipers, dial indicators can be checked by a—
(A) Slip gauge (B) Ring gauge
(C) Plug gauge (D) Feeler gauge

80. A ring gauge is used to—
(A) Check the clearance between two meeting surface
(B) Test the accuracy of holes
(C) Check the diameter of shafts or studs
(D) All of the above

81 The lathe bed is made of—
(A) Pig iron
(B) Alloy steel
(C) Mild steel
(D) Chilled cast iron

82. The angle between the lathe centres is—
(A) 30° (B) 60°
(C) 75° (D) 90°

83. The chuck used for setting up of heavy and irregular shaped work should be—
(A) Magnetic chuck
(B) Drill chuck
(C) Four jaw independent chuck
(D) Three jaw universal chuck

84. Drilling is an example of—
(A) Oblique cutting
(B) Simple cutting
(C) Orthogonal cutting
(D) None of these

85. In a shaper, the metal is removed during—
(A) Forward stroke
(B) Return stroke
(C) Neither the forward stroke nor return stroke
(D) Both the forward and return stroke

86. A mandrel is used to hold—
(A) A thin work
(B) A heavy work
(C) An eccentric work
(D) None of these

87 For turning small taper on long workpiece, the suitable method is—
(A) By swivelling the compound rest
(B) By offsetting the tail stock
(C) By a form tool
(D) By a taper turning attachment

88. In a planer—
(A) Tool and work both reciprocate
(B) Tool is stationary and the work reciprocates
(C) Work is stationary and the tool reciprocates
(D) None of the above

89. Which of the following operations can be performed by a drilling machine ?
(A) Tapping (B) Reaming
(C) Spot facing (D) All of the above

90. According to Indian standards, the total number of tolerance grades are—
(A) 8 (B) 12
(C) 14 (D) 16

91. Which is the most widely used metal for casting ?
(A) Cast iron
(B) Brass
(C) Aluminium
(D) Magnesium alloys

92 The brazing process is carried out in the temperature range—
(A) 80–155°C (B) 170–300°C
(C) 350–500°C (D) 550–670°C

93. In thermit welding, aluminium and iron oxide are mixed in the proportion—
(A) 1 : 2 (B) 1 : 3
(C) 2 : 1 (D) 1 : 1

94. Which of the following belongs to the category of fusion welding ?
(A) Gas welding
(B) Forge welding
(C) Thermit welding with pressure
(D) Electrical resistance welding

95. Which of the process is used primarily to obtain surface finish ?
(A) Boring (B) Broaching
(C) Hobbing (D) Horning

96. The operation of making cone shape enlargement of the end of a hole is called—
(A) Counter Boring
(B) Counter sinking
(C) Step drilling
(D) Spot facing

97. The metal removal during machining is by—
(A) Plastic Distortion (B) Tearing
(C) Shearing (D) Cutting

98. With high speed steel tools, the maximum permissible operating temperature is close to—
(A) 250°C (B) 540°C
(C) 780°C (D) 950°C

99. The cutting edges of a standard twist drill are called—
(A) Flanks (B) Wedges
(C) Lips (D) Flutes

100 A portable drilling machine is specified by—
(A) Spindle speeds and feed
(B) Maximum thickness of job it can drill
(C) Maximum diameter of drill it can hold
(D) Maximum travel of spindle

## Answers

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. (A) | 2. (A) | 3. (B) | 4. (D) | 5. (D) | 51. (B) | 52. (A) | 53. (C) | 54 (A) | 55. (A) |
| 6. (B) | 7. (D) | 8. (C) | 9. (A) | 10 (B) | 56 (B) | 57. (B) | 58 (C) | 59 (A) | 60. (B) |
| 11. (C) | 12. (D) | 13. (A) | 14 (C) | 15. (D) | 61. (C) | 62. (A) | 63. (B) | 64 (D) | 65. (C) |
| 16. (D) | 17. (D) | 18. (D) | 19 (B) | 20. (D) | 66. (C) | 67. (B) | 68 (B) | 69. (B) | 70. (D) |
| 21. (B) | 22. (D) | 23. (B) | 24. (D) | 25. (A) | 71. (D) | 72 (B) | 73. (A) | 74. (B) | 75. (D) |
| 26. (B) | 27. (D) | 28. (D) | 29. (A) | 30. (A) | 76. (A) | 77. (C) | 78 (C) | 79 (A) | 80. (C) |
| 31. (C) | 32. (C) | 33. (C) | 34. (B) | 35. (D) | 81. (D) | 82. (B) | 83. (C) | 84 (A) | 85 (A) |
| 36. (A) | 37. (B) | 38 (B) | 39. (B) | 40. (B) | 86. (D) | 87. (C) | 88 (B) | 89 (D) | 90. (D) |
| 41. (D) | 42. (C) | 43. (C) | 44. (C) | 45. (C) | 91. (A) | 92. (C) | 93. (B) | 94 (A) | 95 (D) |
| 46. (A) | 47. (C) | 48. (A) | 49. (B) | 50. (A) | 96. (B) | 97. (C) | 98. (B) | 99 (C) | 100. (C) |

# 13 AUTOMOBILE ENGINEERING

Automobile is a combination of large number of parts. It can be divided into two major constituents (a) body and (b) the chassis.

The body is that part where passengers have their seats or the luggage and cargo to be carried is placed.

The chassis in the principal machine portion which have constituents like frame, axle, wheel, steering, engine, fuel tank, radiator etc.

Automobile is made up of the following components—

(A) Frame work, (B) Engine, (C) Transmission system, (D) Controls, (E) Super structures, (F) Auxiliaries.

## Automobile Performance

The pressure developed by the burning of fuel in the engine cylinder is transmitted to crankshaft by the piston and connecting rod and a turning force or effort known as torque is produced. The crankshaft is coupled to the driving road wheels through clutch, gear box, propeller shaft, differential and axle shafts in an automobile Thus torque produced by the engine is transmitted through the drive line to the road wheels to propel the vehicle. The torque depends upon the pressure exerted on the piston and the length of crank arm It is measured in newton–meter (N–m). The actual power delivered by the engine is known as brake power. It is measured in watts (W) or kilowatts The number of revolutions per minute (r.p.m ) at which the torque begins to decrease, depends upon the engine design. The torque available at the contact between driving wheel and road is known as tractive effort. At differential the gear box and final drive act as leverage to multiply, torque is inversely proportional to the speed. If the speed of the gear is lower, the torque will be increased in the same proportion and vice-versa. Therefore torque at the driving wheels,

$$T_W = G \times \eta_t \times T_g$$

The engine torque can be increased by reduction gearing. The torque transmitted by the engine through gear box and propeller shaft to the final drive is increased in every gear except in top and overdrive. The torque of final drive, provided a differential is fitted, is always equally divided between each axle shaft irrespective of speed of road wheel. This does not apply to limited slip type differential

## Internal Combustion Engines

The internal combustion engine is a heat engine in which the combustion of fuel with oxygen of the air occurs within the cylinder of the engine. In order to run automobile engines, the air-fuel mixture burns in the engine cylinder to develop power

The commonly used automobile I.C. engines are the following—

**1. Petrol Engine**—During suction stroke the air and fuel (Petrol) mixture is drawn in petrol engines In compression stroke the mixture is approximately compressed 20 to 30 bar, therefore raising the temperature in the range of 400 to 500°C. The temperature reached after compression is below the auto-ignition threshold of the air fuel mixture and hence it is ignited with the help of a spark plug before the piston reaches the top dead centre. The petrol engine works on otto cycle or constant volume cycle.

**2. Diesel Engine**—It is also known as compression ignition engine. In diesel engine, the air is drawn during the suction stroke which is

compressed to approximately 30 to 45 bar (compression ratio 14 to 25), thus raising the air temperature in the range of 700°C to 900°C. The fuel is injected through nozzle and finely dispersed. It evaporates, mixes with air and ignites spontaneously. The pressure increases in the range of 55 to 75 bar during combustion. The burned gases, under full load, are at a temperature of about 600°C but in case of petrol engines it is 900°C. Hence diesel engine utilizes the heat of the fuel to a better degree and for this reason its fuel consumption is lower. The diesel engine works on diesel cycle or constant pressure cycle.

## PARTS OF I.C. ENGINE

**1. Cylinder**—It is the heart of the engine where the fuel is burnt and the power developed.

**2. Cylinder Head**—The cylinder head is usually a one piece casting bolted to the top of the cylinder block. In between the block and the head is given copper asbestos gasket to make gas tight joint. It requires to have good heat conduction and be readily cooled. These are generally made of aluminium alloy but there are also some cast iron cylinder heads.

**3. Cylinder Block**—The material used for the cylinder block is grey cast iron or aluminium alloy. Cylinder block is the foundation of the engine. The other engine parts are attached or assembled into the cylinder block.

**4. Piston**—The main function of a piston is to transmit the force exerted by the burning of charge to connecting rod. The distance that the piston travels from one end of the cylinder to the other is called the stroke. The material used for pistons are aluminium alloys made from aluminium with copper, silicon, nickel etc

**5. Piston Rings**—The piston rings lubricated with engine oil produce gas-tight seal between the piston and the cylinder liner. Generally, there are two types of rings, compression rings and oil control rings. The compression rings are made from special cast iron on carbon steel. The oil control rings are made from carbon steel and their function is to provide effective seal to prevent leakage of the oil into engine cylinder.

**6. Connecting Rod** – It is a link between the piston and crank shaft. The main function of the connecting rod is to transmit force from the piston to the crank shaft. It converts reciprocating motion of the piston into the circular motion of the crank shaft, in the working stroke. The connecting rods are die-forged from special steels such as nickel chrome steel and chrome molybdenum steel

**7. Main bearing**—The crankshaft is supported and is turning in these main bearing.

**8. Crank Shaft**—The crankshaft runs under the action of piston through the connecting rod and crank pin located between crank webs or checks, and transmits the work from the piston to the driven shaft. For crank shaft medium carbon steel material is extensively used. In some higher grade automobile chrome nickel steel is used.

**9. Crank Webs**—These are masses for balancing purpose.

**10. Piston Pins or Wrist Pin**—It connects the piston to the upper end of the connecting rod. Each end of the piston pin fits into the holes bored in piston base.

**11. Intake Valve**—Fresh air enters through this valve operated by a cam.

**12. Cam Shaft**—It is driven from the crankshaft by a timing gear on a chain. It operates the intake valve and the exhaust valve through the cams, cam followers, push rods and rocker arms.

**13. Valve Springs**—These are made from spring steel serve to close the valves.

**14. Fly Wheel**—It takes care of the fluctuations or the cyclic variations in speed. It stores energy during the power stroke and releases during the other strokes thus giving a fairly constant output torque.

## Engine Operations

**1. Suction Stroke**—In this stroke, a mixture of fuel-vapour in correct proportion, is supplied to the engine cylinder

**2. Compression Stroke**—In this stroke, the fuel vapour is first compressed in the engine cylinder

**3. Expansion Stroke**—In this stroke, the fuel vapour is fired just before the compression is

complete. It results in the sudden rise of pressure, due to expansion of the combustion products in the engine cylinder.

**4. Exhaust Stroke**—The product of combustion after expanding during power stroke is pushed out through the exhaust valve. The expansion and exhaust strokes are similar to the gas and the petrol engines.

## Fuel System

**1. Carburettor**—The carburettor is a device for atomising and vaporising the fuel and mixing it with air in varying proportions to suit the charging operation condition in the engine. This process of breaking up and mixing the petrol with air is called carburetion

**2. Fuel Tank**—It is used for storing the fuel.

**3. Fuel Gauge**—It is used to measure the quantity of fuel present in the storage tank.

**4. Fuel Pump**—It is used to draw the fuel from the tank and deliver to the carburettor or injector.

## Cooling System

**1. Air Cooling System**—This type of cooling system is mostly employed in light engines such as in motor cycles and scooters. The air cooled engines contain fins or ribs on the outer surfaces of the cylinders and cylinder heads. These fins provide more area for air contact, resulting in better radiation

**2. Liquid Cooling**—This type of cooling system consists of a radiator, water pump, water jacket, thermostat, fan and other components Each cylinder of the engine is surrounded by a water jacket. A thermostat is fitted between the engine and radiator. When the engine is started from cold, the thermostat closes to prevent coolant from entering the radiator until the engine has warmed up.

## Transmission

The main functions of transmission are as under—

(A) To transfer the engine output power to the final driven gear.

(B) To provide sufficient torque at starting, ascending, accelerating, braking etc.

(C) To provide low to high speed driving capability

(D) To enhance the direction of wheel rotation.

## Clutch

It is a device to continue or discontinue load on the engine. The clutch is installed between the engine and transmission. It transmits the power of the engine generally through the use of friction. The clutch is linked to the clutch pedal in the passenger compartment. The main components of a clutch are engine flywheel, a friction (clutch) disc, and a pressure plate. When the clutch pedal is in the released condition, the pressure plate is pushed solidly in direction of the flywheel by the diaphragm spring, which is located inside the clutch cover. There is no power that can be transmitted through the clutch.

## Battery

The battery in an automobile is used as a chemical storage unit for the electrical energy produced by the alternator. Typically, system voltages are 12V for passenger cars and 24V for commercial vehicles (achieved by connecting two 12V batteries in series).

The working of battery is based on the principle that an electric current is generated when two kinds of metal having different ionization potential are connected with a conductive wire and submerged in an electrolyte. The electrical energy is converted into potential chemical energy during charging and discharging This potential is reconverted into electrical energy

## Discharge of Battery

When the battery discharges, the positive plate containing lead peroxide ($PbO_2$) and negative plate having spongy lead (Pb) combine with sulphuric acid ($H_2SO_4$) to form lead sulphate ($PbSO_4$) and water ($H_2O$). As discharging continues and the sulphuric acid continues to decompose, the concentration of sulphuric acid in the electrolyte gradually declines. The specific gravity of the electrolyte reduces in proportion to the consumption of the

battery. The amount of electricity remaining in a battery can be determined by measuring the specific gravity of the electrolyte. If discharging continues beyond the limit, the lead sulphate formed on plates converts into white crystal. It is called sulphation. At this point, the chemical reaction is irreversible and the battery cannot be recharged.

## Charging of Battery

When a current from a direct current power source is applied to discharged battery, the lead sulphate on the plates is electrochemically decomposed. In this process, sulphur ions are emitted by the plates and the specific gravity of the electrolyte is increased. At the same time active material on plates return to their original state *i.e.*, to lead peroxide and to spongy lead, restoring the battery to full function

During the final stage of battery charging, the emission of sulphur ions from the plates ceases and at the same time, electrolysis of water in the battery begins. The hydrogen gas is emitted around the negative plate and oxygen gas is emitted around the positive plate. When the battery is fully charged, each cell has 2·1 to 2·2 volts. The specific gravity of the electrolyte also increases gradually during charging until gases are given off because there is a little agitation of the fluid When the gas emission begins, the specific gravity increases rapidly, reaching the maximum level at the end of charging and remaining constant thereafter

## Suspension

It is located between the wheels of the vehicle and the body. The suspension system includes springs, shock absorbers and their mountings The purpose of a suspension system is to improve driving comfort, reduce the amount of vibration and import forces that are transmitted to the body

The suspension system can be divided into two major types based on the design.

(A) Rigid axle.

(B) Independent type suspension system.

(A) **Rigid Axle**—In this suspension system the left and right wheels are connected with a single axle and the load directed to the wheels is supported by this system. It is more effective when it is desired to maintain a large suspension stroke in vehicles which exhibit large variation in load as a result of charges in cargo weight or passenger numbers. It is mainly employed in large or medium sized trunks and buses. The main drawback of this type of suspension system is that driving comfort and stability are inferior to that of independent type.

(B) **Independent Type Suspension**—There is no axle connecting the left and right wheels in the independent type of suspension. Therefore the load directed to the wheel is supported by the suspension arms. Driving and stability are superior when this type of suspension is adopted. The independent suspension system has become almost universal incase of front wheels Double wishbone and Mac Pherson strut independent suspension are generally used in automobiles.

## Wheel Alignment

It relates to the relative position of the wheels with respect to the wheel attaching parts and the ground The proper wheel alignment reduces steering effort, provides directional stability and control, reduces tyre slip and wear.

## Wheel Balance

The weight of the wheel should be distributed evenly to create the balanced condition. If the weight is distributed unevenly, centrifugal force causes the wheel to vibrate as it turns. A slight imbalance causes vibrations on the steering wheel. Wheel balance are mainly of two types : (A) Static wheel balance, (B) Dynamic wheel balance

In order to correct static balance, a weight is attached to the wheel directly opposite to the heaviest spot. Whereas in order to correct dynamic unbalance, equal weights are placed 180 degrees apart from each other, one on the inside of the wheel and one on the outside, at the point of unbalance

## Tyres

It performs mainly the following functions—

1. It supports the vehicle weight.
2. It transfers the braking force and traction

3. It changes and maintains the direction of travel.

4. It absorbs road shocks by acting as spring in the total suspension system.

## Basic Structure of Tyre

**1. Tread**—It is the part which comes into contact with the road surface. The tread is made from a mixture of many different kinds of natural and synthetic rubbers. It protects the body and provides high grip, longer life and durability etc.

**2. Bead Wires**—It is a loop of high strength steel cable coated with rubber. It gives the tyre strength. It needs to stay seated on the wheel rim and to handle the forces applied by the tyre mounting machines when tyres are installed on rims.

**3. Side Wall**—It is the most flexible part of the tyre and provides the lateral stability to the tyre.

**4. Body**—It sustains the inflation pressure and endures load and road shocks. The body is made up of several layers of different fabrics, called plies. The most commonly used ply fabric is polyester cord.

## Tyre Size

The tyres are generally specified and designated by the nominal size of their sectional width and the wheel rim diameter The cross-bias ply tyres are generally designated as : 7·5 × 14 × 6 PR

Where, the section width or thickness of tyre from shoulder to shoulder is 7 5 inches, the diameter of the wheel rim is 14 inches and the PR represents the ply rating of the tyre. It represents the maximum recommended load which the tyre can carry when used in specific condition. The radial tyres are generally designated as 145/70 R 1269 S.

Where the section width or thickness of tyre from shoulder to shoulder is 145 mm, the aspect ratio is 70%, R represents the tyre is radial, the diameter of the wheel rim is 12 inches, the load index is 69, the S is the speed symbol.

## Brake System

The brake system reduces wheel rotating speed in order to reduce speed of the vehicle. When brakes are applied on a moving vehicle, the kinetic energy of motion of the vehicle is transformed into heat generated by the friction between the brake and the rotating drum (or disc). The heat generated is dissipated into the surrounding air. The braking system which are commonly used in all automobiles are the following—

(A) **Parking Brake**—It is used to hold the vehicle stationary, when applied. At the time of parking, the braking is necessary to prevent the vehicle from rolling off due to road gradient or blowing wind. The brake manually operates on the rear wheels through cables or mechanical linkage from an auxiliary foot lever or a hand pull

(B) **Service Brake**—Although the most automotive service brakes are hydraulic brakes. The hydraulic action begins when force is applied to the brake pedal. This force creates pressure in the master cylinder, either directly or through a power booster It serves to displace hydraulic fluid stored in master cylinder. The displaced fluid transmits the pressure through the fluid filled brake lines to the wheel cylinders that actuate the brake shoe. The actuation of these mechanisms forces the brake pads and linings against the rotors (front wheel) or drums (rear wheel) to stop the wheel Master cylinder of a brake system converts pedal force into hydraulic pressure to operate the brakes. When the brake pedal is depressed, the piston in the master cylinder are activated, causing pressure act on the brake fluid. When the brake pedal is released, return springs move the pistons back to their original positions. Generally, all the vehicles utilise tandem master cylinders. This type of master cylinder serves two independent hydraulic lines. The master cylinder is fitted with a brake fluid reservoir The fluid in the reservoir compensates for variations in the fluid level that accompany movement of piston and for permanent changes in the quantity of fluid in the brake lines that occur as the brake pads become worn.

# OBJECTIVE QUESTIONS

1. The number of points at which the engine clutch gear box unit is supported on the chassis frame is—
   (A) One (B) Two
   (C) Three (D) Four

2. Weight of the vehicle produces in the side members of the frame—
   (A) Vertucle bending
   (B) Horizontal bending
   (C) Torsion
   (D) All of these

3. The most effectuve section against bending is—
   (A) Rectangular bar
   (B) Round bar
   (C) Round hollow tube
   (D) Square hollow section

4. A clutch is usually designed to transmit maximum torque which is—
   (A) 80 per cent of the maximum engine torque
   (B) 150 per cent of the maximum engine torque
   (C) Equal to the maximum engine torque
   (D) None of the above

5. Clutch facing are usually attached to the plate by—
   (A) Brass rivets (B) Steel rivets
   (C) Steel screw (D) Aluminium screw

6. The mertia of the rotating parts of the clutch should be—
   (A) Zero (B) Minimum
   (C) Maximum (D) None of the above

7. Coefficient of fricton for the clutch facing is approximately—
   (A) 1 2 (B) 0·8
   (C) 0·1 (D) 0·4

8. The clutch is located between the transmission and—
   (A) Differential (B) Engine
   (C) Rear axle (D) Propeller shaft

9. The maximum intensity of pressure which the clutch facing can withstand without being damaged is about—
   (A) 10 Pa (B) 10 kPa
   (C) 100 kPa (D) 1000 kPa

10. Cushioning springs in clutch plate are meant to reduce—
    (A) Vehicle speed
    (B) Jerky starts
    (C) Torsional vibrations
    (D) None of the above

11. Free pedal play in car clutches is about—
    (A) 3 mm (B) 30 mm
    (C) 50 mm (D) 90 mm

12. The thrust bearing should come into contact with the release levers when the—
    (A) Vehicle is running very fast
    (B) Vehicle is stationary
    (C) Clutch pedal is pressed
    (D) Vehicle is driven very slow

13. The parts of the cover assembly that hold pressure plate against the clutch plate are the—
    (A) Release levers (B) Thrust bearings
    (C) Struts (D) Springs

14 Electric brakes are commonly used on—
    (A) Two wheelers (B) Cars
    (C) Trucks (D) Trailers

15 Air Brakers are mostly used in case of—
    (A) Cars (B) Jeeps
    (C) Trucks (D) Three wheelers

16 The hand brake usually operates on—
    (A) Rear wheels (B) Front wheels
    (C) Right wheels (D) Left wheels

17. Brake lining consists mainly of—
    (A) Asbestos (B) Copper
    (C) Cast iron (D) Aluminium

18. The type of reflector used for automobile head lamp is—
    (A) Spherical (B) Parabolic
    (C) Hyperbolic (D) None of these

19. The clutch used in cars is usually –
    (A) Multiple disc type
    (B) Single disc type
    (C) Centrifugal type
    (D) None of these

20. Number of forward gear box speeds in Indian cars is—
    (A) 3 (B) 4
    (C) 5 (D) 6

21. The first Indian car to use disc brakes is—
    (A) Maruti 800
    (B) Maruti 1000
    (C) Ambassador Nova
    (D) Tata Sierra

22. Best spanner for automobile work is the—
    (A) Open ended type
    (B) Combination type
    (C) Ring type
    (D) Socket type

23. The tool employed to measure the shaft run-out is the—
    (A) Feeler gauge (B) Dial gauge
    (C) Micrometer (D) Calliper

24. The materials used for cylinder block are—
    (A) Cast iron and steel
    (B) Cast iron and aluminium alloy
    (C) Steel and aluminium alloy
    (D) Brass and steel

25. The angle between the cylinder axes and the crankshaft centre line in an engine is—
    (A) 75° (B) 90°
    (C) 105° (D) 180°

26. Most difficult gasket sealing problem occurs at the—
    (A) Head
    (B) Timing cover
    (C) Oil pan
    (D) Intake manifold

27. Cam shaft in an engine is always mounted—
    (A) Parallel to the crank shaft
    (B) Perpendicular to the crank shaft
    (C) Inclined to the crank shaft
    (D) None of the above

28. The oil pan in an engine may be made of –
    (A) Cast iron or brass
    (B) Steel or cast iron
    (C) Steel or aluminium
    (D) Cast iron or zinc

29 The largest diameter of a camground piston is
    (A) At the piston land
    (B) Along piston pin axis
    (C) At 90° to the piston pin axis
    (D) At 45° to the piston pin axis

30 Piston pins on some engines are offset to the—
    (A) Right side
    (B) Left side
    (C) Major thrust side
    (D) Minor thrust side

31 The purpose of piston ring is to control—
    (A) Oil consumption
    (B) Combustion pressure
    (C) Cylinder wall lubrication
    (D) All of the above

32 The minimum number of compression rings in an automotive engine is—
    (A) One (B) Two
    (C) Three (D) Four

33 Compression rings are generally made of—
    (A) Low carbon steel
    (B) High carbon steel
    (C) Aluminium
    (D) Cast iron

34. The uppermost ring on a piston is usually plated with—
    (A) Steel (B) Cast iron
    (C) Aluminium (D) Chromium

35 Connecting rod connects the crank shaft and the—
    (A) Cylinder head (B) Cam shaft
    (C) Piston (D) Cylinder block

36. The piston pins in the modern automobile engines are usually—
    (A) Fully-floating
    (B) Semi-floating

(C) Three quarter floating
(D) Fixed to both piston and the connecting rod end

37. The cam shaft controls –
(A) Valve closing (B) Valve opening
(C) Valve timing (D) All of these

38. The cam shaft drive which does not require lubrication is—
(A) Chain drive
(B) Toothed rubber belt
(C) Gear drive
(D) None of these

39. The exhaust valve usually starts opening—
(A) At TDC (B) At BDC
(C) Before TDC (D) Before BDC

40. On the front end of a crank shaft is mounted—
(A) Timing gear
(B) Fan pulley
(C) Vibration damper
(D) All of the above

41. On the rear end of a crank shaft are mounted—
(A) Timing sprocket (B) Flywheel
(C) Counter weight (D) Vibration damper

42 The engine valves are closed by—
(A) Cam shaft (B) Timing valve
(C) Valve springs (D) Crank shaft

43 Exhaust valve face angle is generally—
(A) 30° (B) 45°
(C) 60° (D) 90°

44. Material used for inlet valve is usually—
(A) Austinitic steel
(B) Mimonic alloy
(C) Silicon-chrome steel
(D) Precipitation-hardening steel

45. The most commonly used valve in an automobile engine is—
(A) Sleeve valve (B) Poppet valve
(C) Rotary valve (D) None of these

46. The carbon from the cylinder head is removed with –
(A) Water (B) Scraper
(C) Caustic Soda (D) Soap

47. The engine requires overhauling in case of –
(A) Mechanical failure
(B) Poor compression
(C) Excessive consumption of lubricating oil
(D) All of the above

48 The diesel engine works on—
(A) Carnot cycle (B) Diesel cycle
(C) Otto cycle (D) Rankine cycle

49 The petrol engine works on—
(A) Carnot cycle (B) Diesel cycle
(C) Rankine cycle (D) Otto cycle

50. The petrol engines are also known as—
(A) Steam engines
(B) Compression ignition engine
(C) Spark ignition engine
(D) None of these

51 The type of wheel which cannot be used with a tubeless tyre is—
(A) Disc wheel
(B) Wire wheel
(C) Light alloy wheel
(D) Composite wheel

52 The type of wheel preferred in sports car are—
(A) Wire wheel
(B) Disc wheel
(C) Aluminium alloy steel
(D) Magnesium alloy wheel

53 In case of wire wheel the vehicle weight is supported by the wires in—
(A) Tension (B) Shear
(C) Compression (D) Bending

54. The term 'ply rating' with reference to a tyre refers to the—
(A) Aspect ratio
(B) Rated strength
(C) Actual number of plies
(D) Recommended inflation pressure

55 The purpose of tyre is to—
(A) Increase tread life
(B) Decrease noise level
(C) Increase traction
(D) Provide softer ride

56. Trea distortion in tyre is least on—
(A) Radial tyres
(B) Crossply tyre
(C) Crossply belted tyres
(D) None of these

57. An overinflated tyre will wear the treat most near the—
(A) Edges (B) Corners
(C) Outside (D) Centre

58. 'Heel and toe Wear' in tyre is caused by—
(A) Over-inflation
(B) Under-inflation
(C) Excessive camber
(D) Excessive acceleration and braking

59 The purpose of tyre rotation in automobile is to—
(A) Equalize wear
(B) Avoid ply separation
(C) Get better ride
(D) None of the above

60 The turning circle for a car is approximately—
(A) 1 meter (B) 2 meters
(C) 10 meters (D) 25 meters

61. Most popular manual steering gear for cars today is—
(A) Rank and pinion type
(B) Cam and roller type
(C) Worm and wheel type
(D) Worm and nut type

62. The object of air conditioning a car is to control therein the—
(A) Temperature and pressure
(B) Pressure and humidity
(C) Humidity and temperature
(D) None of these

63. The best hydrocarbons from detonation viewpoint are—
(A) Olefins (B) Paraffins
(C) Naphthalene (D) Aromatics

64 The calorific value of gasoline is about—
(A) 45 J/kg (B) 45 kJ/kg
(C) 45 MJ/kg (D) 45 GJ/kg

65. The process in which higher hydrocarbons are decomposed into smaller hydrocarbons is called -
(A) Cracking (B) Reforming
(C) Polymerisation (D) Alkylation

66 The Octane number of iso-octane is—
(A) 10 (B) 50
(C) 100 (D) 150

67 One effect of detonation is—
(A) Delay in ignition
(B) Loss of Power
(C) Interruption in lubrication
(D) Deterioration in the quality of air fuel mixture

68. An effective method for prevention of detonation is the—
(A) Heating of the charge
(B) Cooling of the charge
(C) Reducing the quantity of aromatics in the fuel used
(D) Locating spark plug at one end of the combustion chamber

69. Octane number of Indian lead-free petrol is—
(A) Less than octane number of leaded petrol
(B) Equal to octane number of leaded petrol
(C) Greater than octane number of leaded petrol
(D) Not satisfied

70. The use of tetraethyl lead in gasolines is being gradually discontinued because—
(A) It has bad odour
(B) It is costly
(C) It decreases the engine efficiency
(D) It blocks the catalytic converter

71 An indication of ignition quality of a diesel fuel is given by—
(A) Octane number (B) Detonation
(C) Cetane number (D) Preignition

72. The primary function of lubrication is to—
(A) Reduce wear
(B) Provide cleaning action
(C) Provide cooling effect
(D) Provide sealing action

73. From the oil pump oil goes directly to—
(A) Oil filter (B) Oil gallery
(C) Oil stainer (D) Main bearings

74. Maximum oil pressure in the lubrication system is controlled by—
(A) Pump rotor
(B) Oil filter
(C) Pressure switch
(D) Pressure relief valve

75. The most important characteristics of a lubricating oil is its—
(A) Physical stability
(B) Chemical stability
(C) Resistance against corrosion
(D) Viscosity

76. The friction that occurs between the layers of oil in an oil film is called—
(A) Boundary friction
(B) Greasy friction
(C) Viscous friction
(D) Solid friction

77. The lubrication system in all modern cars has—
(A) Oil cooler (B) Rotor type pump
(C) Gear type pump (D) Oil filter

78 On leaving the engine the coolant goes to—
(A) Pump inlet (B) Header tank
(C) Collector tank (D) None of these

79 The radiator core is made of—
(A) Brass (B) Steel
(C) Cast iron (D) Plastic

80. A pressure cap contains a—
(A) Thermostat valve
(B) Blow-off valve
(C) Pressure valve
(D) Pressure and vacuum valve

81. The purpose of thermostat is to keep the engine—
(A) Hot
(B) Cool
(C) At desired temperature
(D) None of the above

82. Thermostat valve starts to open at about –
(A) 20°C (B) 50°C
(C) 80°C (D) 90°C

83. Coolant pumps are of—
(A) Vane type
(B) Reciprocating type
(C) Centrifugal type
(D) All of the above types

84 The purpose of fan is to—
(A) Draw air through the radiator
(B) Provide drive to the coolant pump
(C) Increase flow of coolant
(D) Cool the engine by blowing air over it

85. Cooling fans are driven by—
(A) Electricity and belts
(B) Chains and gears
(C) Gears and belts
(D) By all of the above

86. Engine overheating may result due to—
(A) Broken fan belt
(B) Thermostat stuck open
(C) Radiator pressure cap stuck closed
(D) Excess coolant in the system

87. Small holes in the pump body provide a vent for—
(A) Fuel (B) Oil
(C) Water (D) Air

88. The most widely used fuel supply system for car engines is the—
(A) Gravity system (B) Pump system
(C) Vacuum system (D) Pressure system

89. The most accurate petrol injection system is the—
(A) Manifold injection
(B) Direct injection
(C) Port injection
(D) Throttle body injection

90. The throttle valve controls the supply of—
(A) Fuel only
(B) Air fuel mixture
(C) Air only
(D) None of these

91. The amount of fuel delivered by the injector depends upon the—
    (A) Length of time the injector is open
    (B) Size of injector nozzle
    (C) Pressure pushing fuel through the injector
    (D) All of the above factors

92. The venturi in the carburettor causes the—
    (A) Decrease of air velocity
    (B) Decrease of fuel flow
    (C) Decrease of manifold
    (D) Increase of air velocity

93. The choke is usually closed when the engine is—
    (A) Cold (B) Hot
    (C) Idling (D) Accelerating

94. When the choke is applied the fuel comes out from the—
    (A) Main jet
    (B) Idle port
    (C) Progression hole
    (D) Transfer port

95 The carburettor provides the correct quality of air-fuel mixture during—
    (A) Acceleration (B) Starting
    (C) Idling (D) All condition

96. The drive for the mechanical fuel pump is taken from the—
    (A) Cam shaft
    (B) Crank shaft
    (C) Distributor shaft
    (D) None of these

97. The ignition temperature of diesel fuel is about—
    (A) 300°C (B) 400°C
    (C) 500°C (D) 700°C

98. The compression ratio in an automotive diesel engine is usually—
    (A) 7 : 1 (B) 15 : 1
    (C) 22 : 1 (D) 10 : 1

99 The most accurate dynamometer is the—
    (A) Swinging field type
    (B) Hydraulic type
    (C) Eddy current type
    (D) Prony brake type

100 Brake thermal efficiency for S.I. engines usually varies between—
    (A) 25% and 30% (B) 30% and 60%
    (C) 50% and 70% (D) More than 75%

## Answers

| | | | | |
|---|---|---|---|---|
| 1. (C) | 2. (A) | 3. (D) | 4. (B) | 5. (A) |
| 6. (B) | 7. (D) | 8. (B) | 9. (C) | 10 (B) |
| 11. (B) | 12. (C) | 13. (D) | 14. (D) | 15. (C) |
| 16. (A) | 17. (A) | 18 (B) | 19. (B) | 20. (B) |
| 21. (A) | 22. (D) | 23. (C) | 24. (B) | 25. (B) |
| 26. (A) | 27 (A) | 28 (C) | 29. (B) | 30. (B) |
| 31 (D) | 32 (B) | 33. (D) | 34. (D) | 35. (C) |
| 36. (A) | 37. (D) | 38 (B) | 39. (D) | 40. (D) |
| 41 (B) | 42 (C) | 43 (B) | 44. (C) | 45. (B) |
| 46 (B) | 47 (D) | 48 (B) | 49. (D) | 50. (C) |
| 51 (B) | 52 (D) | 53 (A) | 54. (B) | 55. (C) |
| 56. (A) | 57 (D) | 58 (D) | 59. (A) | 60 (C) |
| 61 (A) | 62 (C) | 63 (D) | 64. (C) | 65. (A) |
| 66 (C) | 67 (B) | 68 (B) | 69 (B) | 70. (D) |
| 71 (C) | 72 (A) | 73 (A) | 74. (D) | 75. (D) |
| 76 (C) | 77 (D) | 78 (B) | 79. (A) | 80. (D) |
| 81 (C) | 82 (C) | 83 (C) | 84. (A) | 85. (A) |
| 86. (A) | 87 (A) | 88 (B) | 89 (C) | 90 (B) |
| 91 (D) | 92 (D) | 93 (A) | 94. (A) | 95. (D) |
| 96. (A) | 97 (B) | 98 (C) | 99. (A) | 100. (A) |

# Model Set - 1

1. If a system is in thermodynamic equilibrium with the surroundings, then—
   (A) The energy will transfer from surrounding to the system
   (B) The energy will transfer from system to surroundings
   (C) The energy transfer will not take place
   (D) Both energy and mass transfer take place
2. Heat pump is a device which—
   (A) Converts heat energy into mechanical energy
   (B) Converts mechanical energy into heat energy
   (C) Delivers the heat from low temperature to a high temperature in a cyclic process
   (D) Delivers the heat from high temperature to a low temperature in a cyclic process
3. Boyle's law states that for a given mass of perfect gas—
   (A) Volume is proportional to temperature
   (B) Volume is proportional to pressure
   (C) Pressure it proportional to temperature
   (D) Volume is inversely proportional to pressure
4. Charle s law states that for a given mass of perfect gas—
   (A) Volume is proportional to pressure
   (B) Volume is proportional to temperature
   (C) Volume is inversely proportional to temperature
   (D) Volume is inversely proportional to pressure.
5. The general gas equation is given as—
   (A) $PV = mT$ (B) $\frac{P}{V} = mT$
   (C) $PV = mRT$ (D) $\frac{P}{V} = mRT$
6. In S.I. units pressure is expressed in—
   (A) $kgf/cm^2$ (B) mm. of mercury
   (C) $N/m^2$ or bar (D) None of the above
7. A perfect gas is one which obey's—
   (A) All gas laws
   (B) Only Boyle's law
   (C) Only Charle's law
   (D) None of the above
8. In metric system the unit of heat is given as—
   (A) C.H.U. (B) B.T.U.
   (C) k.cal (D) °kelvin
9. One physical atmosphere (atm) is equal to—
   (A) 76 mm. of mercury
   (B) 760 Torr
   (C) $76\ kg/cm^2$
   (D) $76\ N/m^2$
10. The ratio of specific heat at constant pressure to specific heat at constant volume for air is equal to—
    (A) 1·4 (B) 1·04
    (C) ·14 (D) 14
11. The value of $C_p$ for air is equal to—
    (A) 2·38 k.cal/kg °K
    (B) 0·024 k.cal/kg °K
    (C) 2·238 k.cal/kg °K
    (D) 0·424 k.cal/kg °K
12. Gases have—
    (A) Two specific heats
    (B) Three specific heats
    (C) One specific heat
    (D) None of the above
13. Change of enthalpy during a process is given by—
    (A) $H_2 - H_1 = mC_v (T_2 - T_1)$
    (B) $H_2 - H_1 = mC_p (T_2 - T_1)$
    (C) $H_2 - H_1 = m(C_p - C_v)(T_2 - T_1)$
    (D) $H_2 - H_1 = m\frac{R}{J}(T_2 - T_1)$

14. During throttling process the enthalpy—
    (A) Remains constant
    (B) Will decrease
    (C) Will increase
    (D) None of the above

15. One kg. mol means—
    (A) Mass of a gas of unit volume
    (B) Mass of a gas equal to its molecular weight
    (C) Mass of a gas at N.T.P
    (D) None of the above

16. Which law states that equal volumes of different gases at same temperature and pressure contain equal number of molecules ?
    (A) Joule's law (B) Avogadro's law
    (C) Regnault's law (D) Zeroth law

17. The value of universal gas constant (Ra) is equal to—
    (A) 848 m kgf/kg.mol per °K
    (B) 8·48 m kgf/kg.mol per °K
    (C) 84·8 m kgf/kg.mol per °K
    (D) ·848 m kgf/kg.mol per °K

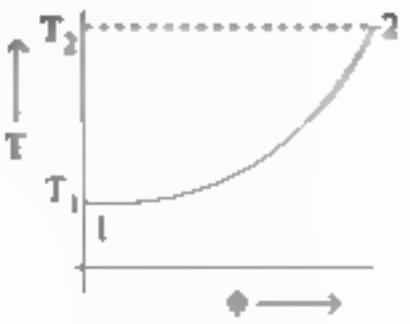
18. If the temperature of the working substance does not change during the process, while its pressure and volume changes it is said to be—
    (A) An adiabatic process
    (B) An isothermal process
    (C) A polytropic process
    (D) A constant volume process

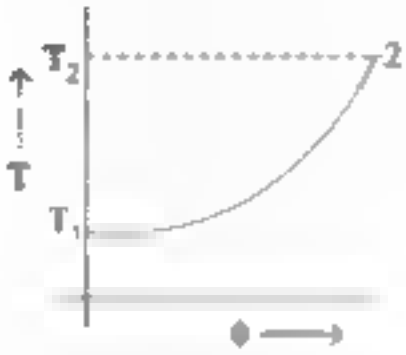
19. Work done is zero in case of—
    (A) Adiabatic process
    (B) Polytropic process
    (C) Constant volume process
    (D) Isothermal process

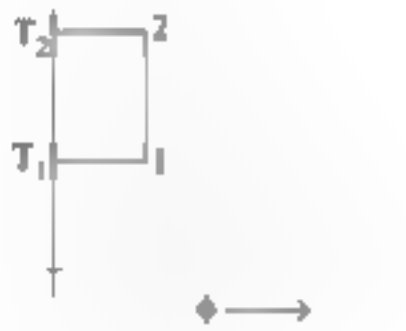
20. Heat can be transferred from low temperature body to high temperature body—
    (A) Without the aid of external work
    (B) With the aid of external work
    (C) Both with or without the aid of external work
    (D) Not possible in any case

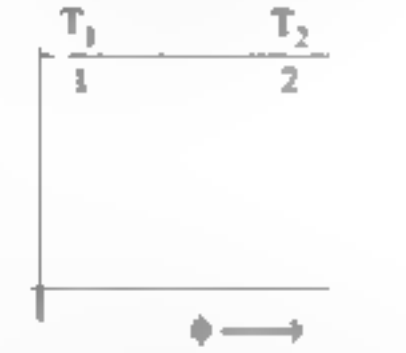
21. Total heat supplied at constant volume is given by the relation—
    (A) $Q = m \times C_p \times (T_2 - T_1)$
    (B) $Q = m \times R\,(T_2 - T_1)$
    (C) $Q = m\,C_v\,(T_1 + T_2)$
    (D) $Q = m\,C_v\,(T_2 - T_1)$

22. Which one represents adiabatic process on T - $\phi$ diagram ?

(A)



(B)



(C)



(D)



23 Change in enthalpy for a small change in temperature ($\Delta T$) is expressed by the relation for a unit mass—
    (A) $\Delta H = \frac{R}{J}\Delta T$ (B) $\Delta H = R\,\Delta T$
    (C) $\Delta H = C_v\,\Delta T$ (D) $\Delta H = C_p\,\Delta T$

24. Internal combustion engine works on—
    (A) First law of thermodynamics
    (B) Second law of thermodynamics
    (C) Zeroth law of thermodynamics
    (D) None of the above

25. The action of the brake in stopping the fly wheel by friction is—
    (A) Reversible process
    (B) Irreversible process
    (C) Isentropic process
    (D) Cannot be predictable

26. Efficiency of the cycle is the ratio of—
    (A) $\frac{\text{Heat supplied}}{\text{Heat rejected}}$
    (B) $\frac{\text{Heat rejected}}{\text{Heat supplied}}$
    (C) $\frac{\text{Heat supplied} - \text{Heat rejected}}{\text{Heat supplied}}$
    (D) $\frac{\text{Heat supplied}}{\text{Heat supplied} - \text{Heat rejected}}$

27. In dual combustion cycle the combustion takes place—
    (A) At constant volume
    (B) At constant pressure
    (C) Partly at constant volume and partly at constant pressure
    (D) None of the above

28. The Carnot efficiency is given by the relation—
    (A) $\frac{T_1 + T_2}{T_1 - T_2}$ (B) $\frac{T_1 - T_2}{T_1 + T_2}$
    (C) $\frac{T_1 - T_2}{T_1}$ (D) $\frac{T_1}{T_1 - T_2}$

29. For calculating air standard efficiency the working fluid is—
    (A) Diesel (B) Petrol
    (C) Air (D) Steam

30 Refrigeration system works on—
    (A) Otto cycle
    (B) Constant pressure cycle
    (C) Carnot cycle
    (D) Bell coleman cycle

31. The air standard efficiency of Ericsson cycle for same temperature limits is equal to the efficiency of—
    (A) Otto cycle (B) Rankine cycle
    (C) Carnot cycle (D) Dual cycle

32. Joule cycle is also known as—
    (A) Eriction cycle
    (B) Otto cycle
    (C) Carnot cycle
    (D) Brayton cycle

33 The change of entropy is given mathematically—
    (A) $\int_1^2 P dV$ (B) $\int_1^2 T$
    (C) $\int_1^2 \frac{dQ}{T}$ (D) $\int_1^2 \frac{T}{dQ}$

34. The unit of entropy is—
    (A) Nm (B) Joules Nm/kg °K
    (C) kJ/K (D) Nm/°K

35 When a gas is heated in any general manner the change in entropy is given by ?
    (A) $\phi_2 - \phi_1 = \frac{R}{J} \log_e \frac{V_2}{V_1} + C_v \log_e \frac{T_2}{T_1}$
    (B) $\phi_2 - \phi_1 = C_p \log_e \frac{V_2}{V_1} + C_v \log_e \frac{T_2}{T_1}$
    (C) $\phi_2 - \phi_1 = C_v \log_e \frac{V_2}{V_1} + C_p \log_e \frac{T_2}{T_1}$
    (D) $\phi_2 - \phi_1 = C_v \log_e \frac{V_2}{V_1} + \frac{R}{J} \log_e \frac{T_2}{T_1}$

36. In reversible adiabatic process the change in entropy is—
    (A) Maximum (B) Minimum
    (C) Zero (D) Variable

37 Change in entropy depends on—
    (A) Mass transfer (B) Heat transfer
    (C) Temperature (D) None of the above

38. Which one is natural solid fuel ?
    (A) Charcoal (B) Coke
    (C) Peat (D) None of the above

39. The temperature of 0·5 kg. of a gas at the begining of an adiabatic expansion is 427°C and at the end is 27°C. The change in entropy is equal to—
    (A) 0·5 × [700 – 300]
    (B) Zero
    (C) 0·5 × [427 + 27]
    (D) $0{\cdot}5 \times C_p \times \int_{27}^{427}$

40. Coke is prepared from—
    (A) Peat (B) Wood
    (C) Bituminous (D) Producer gas

41. The area under the curve on temperature entropy diagram represents –
    (A) Work done during the process
    (B) Change in entropy
    (C) Heat transfer for irreversible process
    (D) Heat transfer for reversible process

42. 100 kg of air contains—
    (A) 21 kg of oxygen
    (B) 35 kg of oxygen
    (C) 23 kg of oxygen
    (D) 73 kg of oxygen

43. In an isothermal process—
    (A) Heat supplied = work done
    (B) Heat supplied = change in internal energy
    (C) Heat supplied = work done + change in internal energy
    (D) None of the above

44. When the fluid suddenly expands into vacuum chamber through a large orifice the process is known as—
    (A) Throttling process
    (B) Adiabatic process
    (C) Isentropic process
    (D) Free expansion

45. Relation between P, V and T for a polytropic process is given by—

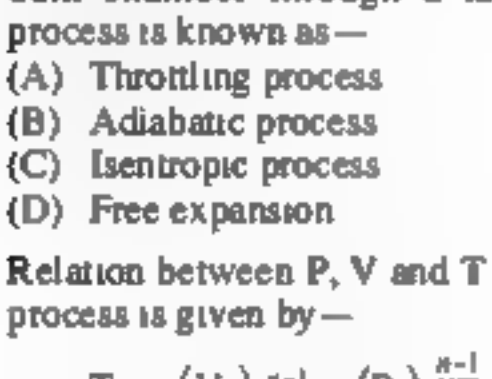
    (A) $\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{n-1} = \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}}$

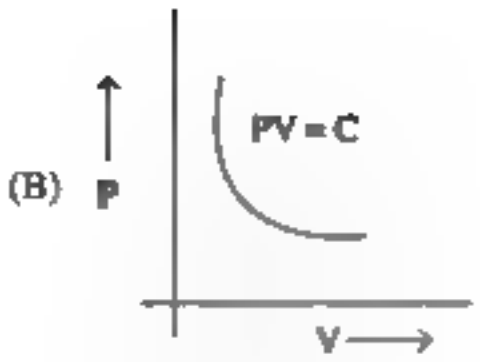
    (B) $\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{n-1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}$

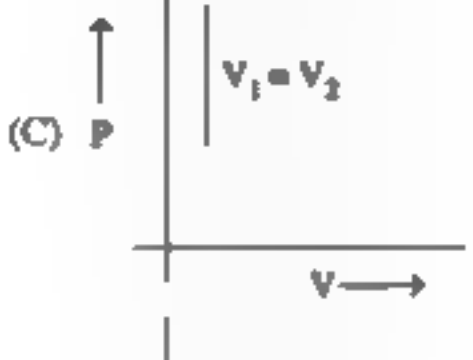
    (C) $\frac{T_1}{T_2} = \left(\frac{V_1}{V_2}\right)^{n-1} = \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}}$

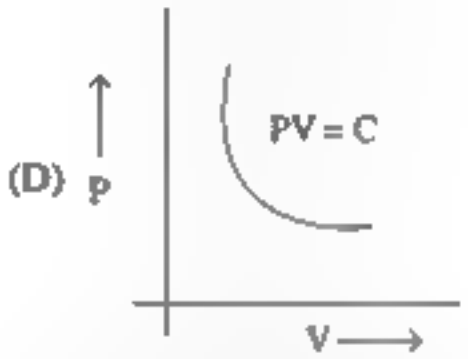
    (D) $\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{\frac{n-1}{n}} = \left(\frac{P_1}{P_2}\right)^{n-1}$

46. The polytropic process on P-V diagram is represented by the figure—

    (A) 


    (B) 


    (C) 


    (D) 


47. Carnot cycle consists of—
    (A) Two reversible adiabatic and two isothermal processes
    (B) Two adiabatic and two constant volume processes
    (C) Two adiabatic and two constant pressure processes
    (D) Two isothermal and two constant pressure processes

48. Gas turbine works on—
    (A) Constant Volume cycle
    (B) Otto cycle
    (C) Ericsson cycle
    (D) Joule cycle

49. Which fuel has the maximum percentage of carbon ?
    (A) Wood (B) Coke
    (C) Lignite (D) Bituminous coal

50. The dryness fraction is given by the relation—
    (A) $\frac{W + \omega}{W}$ (B) $\frac{W}{W}\ \omega$
    (C) $\frac{W}{W + \omega}$ (D) $\frac{W + \omega}{W}\ \omega$

51. When water is heated at constant pressure till it reaches its boiling point the heat added during the process is known as—
    (A) Latent heat (B) Sensible heat
    (C) Super heat (D) Specific heat

52. During the superheating of the steam at constant pressure, the—
    (A) Temperature of the steam remains constant
    (B) Temperature of the steam does not remain constant
    (C) Internal energy of steam remains constant
    (D) Enthalpy remains constant

53. If the temperature of steam formed at atmospheric pressure is 110°C, the steam formed is—
    (A) Wet (B) Dry and saturated
    (C) Super heated (D) Unpredictable

54. During the transformation of water into steam, the temperature remains constant, the heat added is known as—
    (A) Liquid heat
    (B) Total heat
    (C) Latent heat of steam
    (D) Specific heat

55 Separating and throttling calorimeter is used for determining—
    (A) Calorific value of fuel
    (B) Dryness fraction of steam
    (C) Specific heat of water
    (D) Viscosity of oil

56. The calorimeter used for finding out accurate dryness fraction of steam is—
    (A) Barrel calorimeter
    (B) Separating calorimeter
    (C) Throttling calorimeter
    (D) Combined separating and throttling calorimeter

57. A closed vessel containing water or any thermal liquid that is heated or vaporised and then removed is known as a—
    (A) Boiler (B) Re-Boiler
    (C) Accumulator (D) None of the above

58. When the steam is produced at a critical pressure and temperature of a boiler, the density of the steam produced is—
    (A) More than water (B) Less than water
    (C) Equal to water (D) None of the above

59 A positive circulation boiler is that in which—
    (A) The water or steam is forced through the boiler circuit
    (B) The flue gases are forced through the boiler circuit
    (C) Draught is produced with the help of exhaust steam
    (D) None of the above

60. In a binary vapour cycle the medium used for the energy transfer is—
    (A) Steam alone
    (B) Mercury
    (C) Steam and mercury
    (D) None of the above

61 The maximum percentage recovery of heat energy from the flue gases take place in—
    (A) Superheater (B) Air preheater
    (C) Economiser (D) Steam ejector

62. Factor of evaporation is given by the relation—
    (A) $\frac{H - h\omega}{539}$ (B) $\frac{H + h\omega}{539}$
    (C) $\frac{H + L + h\omega}{539}$ (D) $\frac{H + L - h\omega}{539}$

63. The term heating surface in boiler means—
    (A) The area of grate
    (B) Volume of the furnace
    (C) The surface area which is in contact with the flue gases
    (D) The outer surface area of the shell

64. The capacity of boiler is defined as—
    (A) The volume of feed water inside the shell
    (B) The volume of the steam space inside the shell
    (C) The maximum pressure at which steam can be generated
    (D) Amount of water converted into steam from 100°C in one hour

65. The scale formation in the boiler is due to -
    (A) Presence of suspended impurities in the water
    (B) Presence of sulphur contents in the fuel
    (C) Presence of chemical impurities in the water
    (D) Excessive moisture contents in the air

66. The function of precipitator in the boiler is—
    (A) To control water particles in steam
    (B) To minimise the ash particles in the flue gases escaping through chimney
    (C) To control chemical impurities in feed water
    (D) To control the rate of combustion of fuel

67. For the safety of boiler which of the mounting is provided more than one in number.
    (A) Fusible plug
    (B) Safety valve
    (C) Feed check valve
    (D) Steam stop valve

68. The term priming in a boiler means—
    (A) The firing of boiler
    (B) The removal of air from the boiler shell
    (C) The formation of bubbles in the boiler shell
    (D) The flow of flue gases through the boiler

69. The maximum heat loss in a boiler occurs due to—
    (A) Heat carried away by the flue gases passing through the chimney
    (B) Unburnt fuel in ash
    (C) Leakage of steam
    (D) Moisture contents in air

70. The feed water injector is operated by the—
    (A) Electric motor (B) Steam engine
    (C) Steam turbine (D) None of the above

71. The function of steam trap is—
    (A) To control the supply of steam
    (B) To blow off excess of steam
    (C) To drain off water resulting from condensations of steam from steam pipes
    (D) To prevent dust particles going with steam

72. The type of safety valve recommended for high pressure boiler is—
    (A) Dead weight safety valve
    (B) Lever safety valve
    (C) Spring loaded safety valve
    (D) None of the above

73. If the diameter of fuel tubes and water tubes is same, then the heating surface will be—
    (A) More in case of water tube boiler
    (B) More in case of fire tube boiler
    (C) Same in water tube as well as fire tube boiler
    (D) Unpredictable

74. Theoretical mean effective pressure ($P_m$) of steam engine is given by the relation—
    (A) $P_m = \frac{P_1(1-\log_e r)}{r} - P_b$
    (B) $P_m = \frac{P_1(1+\log_e r)}{r} - P_b$
    (C) $P_m = \frac{P_1(1+\log_e r)}{r} + P_b$
    (D) $P_m = \frac{P_1(1-\log_e r)}{r} + P_b$

75. Indicated horse power developed inside the steam engine cylinder is given by the relaton—
    (A) $I.H.P = \frac{P_m LAN}{75 \times 60}$
    (B) $I.H.P = \frac{2P_m LAN}{75 \times 60}$
    (C) $I.H.P = \frac{4P_m LAN}{75 \times 60}$
    (D) $I.H.P = \frac{2P_m LAN}{60}$

76 The linear motion of the piston is converted into rotory motion by the—
    (A) Crank (B) Piston rod
    (C) Connecting rod (D) Cross-head

77. Weight per H.P. of compound steam engine as compared to simple steam engine is—
    (A) More
    (B) Less
    (C) Equal
    (D) Depending on the inlet pressure of steam

78. If 'L' is the stroke length and r is the crank radius then –
(A) $L = r$ (B) $L = 4r$
(C) $L = \frac{r}{2}$ (D) $L = 2r$

79. I.C. engine works on—
(A) Zeroth law of thermodynamics
(B) Second law of thermodynamics
(C) First law of thermodynamics
(D) None of the above

80. The thermal efficiency of an I.C. engine is in the range of—
(A) 10 to 15% (B) 15 to 20%
(C) 20 to 25% (D) 35 to 45%

81. In two stroke engine the cycle is completed in—
(A) Four revolution of the crank shaft
(B) Two revolution of the crank shaft
(C) One revolution of the crank shaft
(D) Half revolution of the crank shaft

82. Compression ratio of an engine is given the relation—
(A) $CR = \frac{V_c}{V_s}$ (B) $CR = \frac{V_c + V_s}{V_c}$
(C) $CR = \frac{V_s - V_c}{V_c}$ (D) $CR = \frac{V_c}{V_s + V_c}$

83. The gap between electrodes of a spark plug is about—
(A) 0·1 mm (B) 0·6 mm
(C) 6 mm (D) 0·06 mm

84 Which of the following is related to the secondary circuit of an ignition system ?
(A) Primary coil (B) C.B points
(C) Spark plug (D) Ignition switch

85. The percentage of heat carried away by the cooling system is—
(A) 80% of the total heat supplied
(B) 60% of the total heat supplied
(C) 30% of the total heat supplied
(D) 10% of the total heat supplied

86. The function of a radiator is to—
(A) Cool the lubricating oil
(B) Cool the hot water from the engine jacket
(C) Supply air for cooling
(D) Filter water used for cooling

87. The firing order of a six cylinder engine is —
(A) 1 - 5 - 3 - 4 - 2 - 6
(B) 1 - 2 - 3 - 4 - 5 - 6
(C) 6 - 5 - 1 - 2 - 3 - 4
(D) 1 - 3 - 2 - 5 - 4 - 6

88 For good lubrication the oil used should have—
(A) Low flash point
(B) Low viscosity index
(C) High viscosity index
(D) Low pour point

89. During starting the gasoline engine requires—
(A) Rich mixture
(B) Weak mixture
(C) Chemically correct mixture
(D) Very lean mixture

90. The SAE number of lubricating oil represents—
(A) The viscosity range
(B) Its flash point
(C) Its pour point
(D) None of the above

91 The function of an injector is—
(A) To vaporise the diesel oil
(B) To atomise the diesel oil
(C) To mix diesel oil with air
(D) To inject lubricating oil

92. The cetane number of alpha-methyl-napthalene is—
(A) 100 (B) 70
(C) 0 (D) 90

93. The octane number rating indicates the anti-knock a quality of a—
(A) Coal fuel (B) Diesel oil
(C) Gasoline fuel (D) Wood fuel

94. Pre-ignition occurs in a—
(A) Diesel engine (B) Steam engine
(C) Gasoline engine (D) Steam turbine

95. By using high octane number fuel the—
(A) Changes of knocking will increase
(B) Higher compression ratio can be used
(C) Thermal efficiency will decrease
(D) Volumetric efficiency will increase

96. The nucleus of an atom consists of –
(A) Protons and electrons
(B) Protons and neutrons

(C) Neutrons and electrons
(D) None of the above

97. Each proton carries a single unit—
(A) Positive charge (B) Negative charge
(C) Neutral charge (D) Unpredictable

98. Each electron carries a single unit—
(A) Negative charge (B) Positive charge
(C) Neutral charge (D) None of the above

99. The method of identifying the element is—
(A) ${}_{Z}X^{A}$ (B) $X^{AZ}$
(C) ${}_{A}X^{Z}$ (D) $X^{A/Z}$
Where X is the symbol for an element.

100. The compound nucleus has—
(A) Kinetic energy
(B) Binding energy of bombarding particles
(C) Both kinetic and binding energy of bombarding particles
(D) None of the above

101. The slenderness ratio of a long column is—
(A) 10–20 (B) 20–30
(C) 50–60 (D) Above 80

102. The value of Rankine's constant for mild steel is—
(A) $\frac{1}{9000}$ (B) $\frac{1}{7500}$
(C) $\frac{1}{1600}$ (D) $\frac{1}{750}$

103. In a simply reinforced beam, the reinforcement is provided in—
(A) Tensile zone (B) Compressive zone
(C) Neutral zone (D) Anywhere

104. A riveted joint may fail due to—
(A) Shearing of rivets
(B) Crushing of rivets
(C) Tearing of the plates
(D) All of these

105. The deflection of a closely-coiled helical spring of diameter (D) subjected to an axial load (W) is—
(A) $\frac{64\,WR^3n}{Cd^4}$ (B) $\frac{64\,WR^2n}{Cd^4}$
(C) $\frac{64\,WRn}{Cd^4}$ (D) $\frac{64\,WRn^2}{Cd^4}$

106. In a leaf spring, maximum bending stress developed in the plates is—
(A) $\frac{Wl}{nbt^2}$ (B) $\frac{2Wl}{nbt^2}$
(C) $\frac{3Wl}{nbt^2}$ (D) $\frac{3Wl}{2nbt^2}$

107. When a closely coiled spring is subjected to an axial load, it is said to be under—
(A) Bending (B) Shear
(C) Torsion (D) All of these

108. Polar moment of inertia of a solid shaft of diameter (D) is—
(A) $\frac{\pi}{16} \times D^3$ (B) $\frac{\pi}{16} \times D^4$
(C) $\frac{\pi}{32} \times D^3$ (D) $\frac{\pi}{32} \times D^4$

109. When a solid shaft is subjected to torsion, the shear stress induced in the shaft at its centre is—
(A) Zero (B) Minimum
(C) Maximum (D) Average

110. Maximum deflection of a cantilever is equal to—
(A) $\frac{Wl^4}{2EI}$ (B) $\frac{Wl^4}{3EI}$
(C) $\frac{Wl^4}{8EI}$ (D) $\frac{Wl^4}{16EI}$

## Answers

| | | | | |
|---|---|---|---|---|
| 1 (C) | 2 (C) | 3 (D) | 4 (B) | 5. (C) |
| 6 (C) | 7 (A) | 8 (C) | 9 (B) | 10. (A) |
| 11 (C) | 12 (A) | 13 (B) | 14. (A) | 15. (B) |
| 16 (B) | 17 (A) | 18 (B) | 19 (C) | 20. (B) |
| 21 (D) | 22 (C) | 23 (D) | 24. (A) | 25 (B) |
| 26 (C) | 27 (C) | 28 (C) | 29. (A) | 30. (D) |
| 31 (C) | 32 (D) | 33 (C) | 34 (C) | 35. (A) |
| 36 (C) | 37 (B) | 38 (C) | 39 (B) | 40 (C) |
| 41 (D) | 42 (C) | 43 (A) | 44. (D) | 45. (A) |
| 46. (D) | 47 (A) | 48 (C) | 49 (B) | 50 (C) |
| 51 (B) | 52 (B) | 53 (C) | 54 (C) | 55 (B) |
| 56. (D) | 57 (B) | 58 (C) | 59. (A) | 60 (C) |
| 61 (C) | 62 (A) | 63 (C) | 64. (D) | 65 (C) |
| 66 (B) | 67 (B) | 68 (C) | 69. (A) | 70. (D) |
| 71 (C) | 72 (C) | 73 (A) | 74 (B) | 75 (B) |
| 76. (A) | 77 (B) | 78 (D) | 79 (C) | 80. (D) |
| 81 (C) | 82 (B) | 83. (B) | 84 (C) | 85 (C) |
| 86 (B) | 87 (A) | 88 (C) | 89. (A) | 90. (A) |
| 91 (B) | 92 (B) | 93 (C) | 94 (C) | 95. (B) |
| 96 (B) | 97 (A) | 98. (A) | 99 (C) | 100. (C) |
| 101 (D) | 102 (B) | 103 (A) | 104. (D) | 105. (A) |
| 106 (C) | 107 (C) | 108 (D) | 109. (A) | 110. (C) |

# Model Set - 2

1. Which one is fertile material—
   (A) $U^{235}$ (B) $U^{239}$
   (C) $U^{233}$ (D) $U^{238}$
2. The radiation emitted are of—
   (A) Two type (B) Three type
   (C) Four type (D) None of above
3. The term PWR stands for—
   (A) Power Water Reactor
   (B) Pressurized Water Reactor
   (C) Power Welding Rod
   (D) Power Work Reaction
4. In sodium graphite reactor the coolant used is—
   (A) Water (B) Graphite
   (C) Heavy water (D) Liquid-sodium
5. The coolant used in a nuclear power plant is—
   (A) Heavy water (B) Freon
   (C) Carbon dioxide (D) Sulphur dioxide
6. The material used for reactor vessel is—
   (A) Cast iron (B) Stainless steel
   (C) Mild steel (D) Copper
7. Select the moderator used in a nuclear power plant—
   (A) Uranium (B) Plutonium
   (C) Hydrogen (D) Oxygen
8. In a sodium graphite reactor, the moderator used is—
   (A) Heavy water (B) Light water
   (C) Graphite (D) None of the above
9. The material used for shielding a core is—
   (A) Concrete
   (B) Thick galvanized sheets
   (C) Copper sheets
   (D) Aluminium sheets
10. Which of the element is natural radio-active –
    (A) Radium (B) Thorium
    (C) Uranium (D) All of the above
11. In boiling water reactor steam is generated—
    (A) In the reactor vessel
    (B) In the boiler
    (C) In the heat exchanger
    (D) None of the above
12. The pressurized water reactor uses light water as—
    (A) Coolant
    (B) Moderator
    (C) Both moderator and coolant
    (D) None of the above
13. The basic law of heat conduction is known as—
    (A) Newton's law (B) Fourier's law
    (C) Regnault's law (D) Dalton's law
14. The unit of thermal conductivity is—
    (A) cal $m^{-1}k^{-1}s^{-1}$ (B) cal
    (C) cal $k^{-1}s^{-1}$ (D) cal $m^{-1}s^{-1}$
15. The thermal resistance is given by the relation—
    (A) $R_c = \frac{x}{kA}$ (B) $R_c = \frac{A}{xk}$
    (C) $R_c = \frac{k}{A.x}$ (D) $R_c = x.k.A$
16. The unit of film heat transfer coefficient is—
    (A) k.cal./$m^2$ (B) k.cal./$m^2$/hr
    (C) k.cal./$m^2$/hr/K (D) k.cal./$m^2$/K
17. If the body is at thermal equilibrium then—
    (A) Emissivity = absorptivity
    (B) Emissivity > absorptivity
    (C) Emissivity < absorptivity
    (D) None of the above

18. The dimension of force is –
(A) $[M^2LT^2]$ (B) $[ML^2T^{-2}]$
(C) $[MLT^{-2}]$ (D) $[M^{-1}LT]$

19. With the help of fans the heat transfer can be increased by—
(A) 4 times (B) 6 times
(C) 8 times (D) 10 times

20. The latent heat of ammonia is—
(A) 540 k.cal./kg (B) 314 k.cal./kg
(C) 50 k.cal./kg (D) 81 k.cal./kg

21. A refrigerant should have—
(A) High specific heat
(B) High specific volume
(C) High latent heat
(D) High boiling point

22. Which of the refrigerant has lowest boiling temperature ?
(A) Carbon dioxide (B) Ammonia
(C) Freon-12 (D) Freon-22

23. The chemical formula of Freon-12 is—
(A) $CCl_4$ (B) $CCl_4F_2$
(C) $CHCl_2F$ (D) $C_2H_5Cl$

24. The boiling point of Freon-12 at atmospheric pressure is—
(A) 100°C (B) 29·8°C
(C) –50°C (D) –29·8°C

25. Which of the following refrigerant has maximum latent heat ?
(A) Sulpher dioxide
(B) Carbon dioxide
(C) Ammonia
(D) Dichloro-difloro-methane

26. Which of the following is known as dry ice ?
(A) Solid carbon dioxide
(B) Liquid ammonia
(C) Milky coloured ice
(D) Liquid sulphur dioxide

27 The boiling point of sulphur dioxide at atmospheric pressure is—
(A) +10°C (B) –15°C
(C) –10°C (D) +15°C

28. Which of the refrigerant is more toxic ?
(A) Freon-12 (B) Freon-22
(C) Ammonia (D) Carbon dioxide

29. Which of the following refrigerant is more costly ?
(A) Ammonia
(B) Carbon dioxide
(C) Methyl chloride
(D) Freon-12

30. The boiling point of carbon dioxide at atmospheric pressure is—
(A) –30°C (B) –78·5°C
(C) –29·8°C (D) –40·8°C

31 Relative C.O.P. is equal to—
(A) $\frac{\text{Actual C.O.P.}}{\text{Work input}}$
(B) $\frac{\text{Net refrigerating effect}}{\text{Work input}}$
(C) $\frac{\text{Actual C.O.P}}{\text{Theoretical C.O.P.}}$
(D) $\frac{\text{Theoretical C.O.P.}}{\text{Actual C.O.P}}$

32 The unit for refrigerating effect is—
(A) Kelvin (K) (B) k.cal./min.
(C) k.cal. (D) k.cal/J

33 C.O.P is always—
(A) More than one (B) Less than one
(C) Equal to one (D) Unpredictable

34. Aqua ammonia is the solution of ammonia and—
(A) Freon-12 (B) Freon-22
(C) Water (D) Carbon dioxide

35 The common refrigerant used in domestic refrigerator is—
(A) Ammonia (B) Sulphur dioxide
(C) Freon (D) Carbon dioxide

36. The decrease in compressor suction pressure will—
(A) Increase the C.O.P
(B) Decrease the C.O.P
(C) Decrease the work done by the compressor
(D) None of the above

37. The use of compressor is not required in—
    (A) Vapour compression system
    (B) Bell coleman refrigerator
    (C) Vapour absorption system
    (D) Air refrigeration system

38. Which of the following compressor does not have any moving part ?
    (A) Reciprocating (B) Rotary
    (C) Thermo (D) Centrifugal

39. The percentage of oxygen by volume in air is equal to—
    (A) 32% (B) 23%
    (C) 21% (D) 12%

40. In evaporative cooling—
    (A) Sensible heat is added to the air
    (B) Latent heat removed from the air
    (C) Air is cooled and humidified
    (D) Air is cooled and dehumidified

41. The boiling of refrigerant takes place in the—
    (A) Compressor (B) Condenser
    (C) Evaporator (D) None of the above

42. The function of an intercooler is to—
    (A) Cool the lubricating oil
    (B) Cool the cylinder body
    (C) Cool the compressed air between the stages
    (D) Cool the inlet air before suction

43 Free air delivered (F.A.D.) is the air at—
    (A) 0°C
    (B) 0°C and 1 kg/cm$^2$ pressure
    (C) 1·0332 kg/cm$^2$ abs. and 15°C
    (D) 273°C and 1 kg/cm$^2$ pressure

44. The volumetric efficiency of a reciprocating compressor is equal to—
    (A) $1+k-k\left(\frac{P_2}{P_1}\right)$ (B) $1+k+k\left(\frac{P_2}{P_1}\right)^{1/n}$
    (C) $1+k-k\left(\frac{P_2}{P_1}\right)^{1/n}$ (D) $1+k-k\left(\frac{P_2}{P_1}\right)^{n}$

45 The volumetric efficiency of an air compressor is the ratio of –
    (A) Displacement volume to clearance volume
    (B) Displacement volume to volume of air sucked inside the cylinder
    (C) Volume of air sucked to the displacement volume
    (D) Volume of air before compression to the volume of air after compression

46. The loss due to drift in cooling tower is—
    (A) 5 to 10 % (B) 10 to 15%
    (C) 30 to 40% (D) 40 to 50%

47 The number of air change per hour recommended for restaurant kitchens are—
    (A) 10 (B) 25
    (C) 15 (D) 5

48. Rotary compressors are used for producing—
    (A) Large quantity of air at high pressure
    (B) Large quantity of air at low pressure
    (C) Small quantity of air at low pressure
    (D) Small quantity of air at high pressure

49. Rotary compressors are used to compress fluids upto—
    (A) 10 kg/cm$^2$ (B) 1·0 kg/cm$^2$
    (C) 50 kg/cm$^2$ (D) 100 kg/cm$^2$

50. The maximum capacity of a reciprocating compressor is—
    (A) 100 m$^3$/min (B) 200 m$^3$/min
    (C) 300 m$^3$/min (D) 1000 m$^3$/min

51 The work done will be least if the compressor is—
    (A) Isothermal (B) Polytropic
    (C) Isentropic (D) None of the above

52 The work done to compress a unit mass of air will be minimum when—
    (A) $n = 1$ (B) $n > 1$
    (C) $n < 1$ (D) $n = r$

53 The type of compressor used in an aeroplane is –
    (A) Reciprocating (B) Centrifugal
    (C) Axial flow (D) Root blower

54. The open cycle gas turbine works on—
    (A) Otto cycle (B) Diesel cycle
    (C) Joule cycle (D) Dual cycle

55. In a gas turbine the air is compressed to a pressure of –
    (A) 3 to 6 kg/cm$^2$
    (B) 30 to 60 kg/cm$^2$
    (C) 0·3 to 0·6 kg/cm$^2$
    (D) 10 to 15 kg/cm$^2$

56. The type of compressor used in gas turbine is—
    (A) Reciprocating
    (B) Rotary
    (C) Centrifugal
    (D) None of the above

57. The maximum permissible inlet temperature of a gas turbine is about—
    (A) 500°C (B) 900°C
    (C) 1500°C (D) 2000°C

58. Constant volume gas turbine works on—
    (A) Joule cycle
    (B) Otto cycle
    (C) Carnot cycle
    (D) Atkinson cycle

59 The size of a gas turbine plant can be reduced by using—
    (A) An intercooler
    (B) A reheater
    (C) Combination of both, *i.e* intercooler and reheater
    (D) Any of the above

60. The ideal air standard efficiency of a Joule cycle is expressed as—
    (A) $\eta = 1 - \frac{1}{r_p^{\frac{r-1}{r}}}$
    (B) $\eta = 1 + \frac{1}{r_p^{\frac{r}{r}} 1}$
    (C) $\eta = 1 - \frac{1}{r_p^{\frac{r+1}{r}}}$
    (D) $\eta = 1 - \frac{1}{r_p{}_{r-1}}$

61. The Jet propulsion engine is based on –
    (A) Newton's second and third laws of motion
    (B) Newton's first law of motion
    (C) Second law of thermodynamics
    (D) Zeroth law of thermodynamics

62 Which one is not related to the rocket engine?
    (A) Nozzle
    (B) Combustion chamber
    (C) Compressor
    (D) Propellant

63. The turbojet engines are rated on the basis of—
    (A) Horse power
    (B) Thrust
    (C) Turbine efficiency
    (D) None of the above

64. The best speed range for a turbojet engine is—
    (A) 300 to 500 km/hour
    (B) 200 to 400 km/hour
    (C) 800 to 1800 km/hour
    (D) 2000 to 5000 km/hour

65. The rocket motor is cooled—
    (A) By circulating water around the engine walls
    (B) By providing fins on the engine walls
    (C) By circulating fuel around the engine walls
    (D) By injecting water in the combustion chamber

66. The air fuel ratio used in a ram jet engine is—
    (A) 5 : 1 (B) 10 : 1
    (C) 15 : 1 (D) 25 : 1

67 The fuel used in solid propellant rocket is—
    (A) Coal
    (B) Kerosene
    (C) Mixture of nitroglycerine and nitra-cellulose
    (D) Charcoal

68. The term cold engine is used for a rocket engine operating on—
    (A) Monopropellant fuel $H_2O_2$
    (B) Bipropellant fuel
    (C) Gasoline fuel
    (D) Alcohol

69. The use of hydrogen peroxide in submarine engine is ideal because –
   (A) It is economical propellant for producing propulsive power
   (B) It provides the free oxygen for the combustion of fuel during sbmerged condition
   (C) It releases large amount of heat during decomposition
   (D) The temperature after its decomposition is very high

70. Which one of the following is more rigid ?
   (A) Cork (B) Chalk
   (C) Wood (D) Rubber

71. States deals with forces—
   (A) Which do not change the state of body at rest or in motion
   (B) Which change the state of body
   (C) Which cause motion of a body
   (D) None of the above

72 An internal force is that which —
   (A) Causes a body to move
   (B) Prevents a body from moving
   (C) Produces internal stresses in the body
   (D) Prevents a body from deformation

73 A vector of unit length is known as—
   (A) Free vector (B) Sliding vector
   (C) Fixed vector (D) Unit vector

74 Force is a—
   (A) Scaler quantity
   (B) Vector quantity
   (C) Linear quantity
   (D) Unpredictable

75. Bow's notation is used for representation of a—
   (A) Mass (B) Velocity
   (C) Force (D) Couple

76 The bell crank lever is a —
   (A) Straight lever
   (B) Compound lever
   (C) Simple bent lever
   (D) None of the above

77. The director of resultant is given by relation—
   (A) $\theta = \tan^{-1} \frac{\Sigma H}{\Sigma V}$
   (B) $\theta = \tan^{-1} \frac{\Sigma V}{\Sigma H}$
   (C) $\theta = \tan^{-1} \left(\frac{\Sigma H}{\Sigma V}\right)$
   (D) $\theta = \tan^{-1} \Sigma H \times \Sigma V$

78 The mass moment of inertia is the—
   (A) Second moment of force
   (B) Second moment of mass
   (C) Second moment of area
   (D) None of the above

79. In S I. system, the unit for mass moment of inertia is –
   (A) kg $m^2$ (B) kg metre
   (C) kg $m^2$ (D) kg/metre

80. The radius of gyration of a circular section is equal to—
   (A) $\frac{D}{2}$ (B) $\frac{D}{3}$
   (C) $\frac{D^2}{2}$ (D) $\frac{D}{4}$

81. The centre of gravity of semi-circular figure is situated at a distance of—


   (A) $\frac{4r}{3\pi}$ from base (B) $\frac{3r}{4\pi}$ from base
   (C) $\frac{2r}{3\pi}$ from base (D) $\frac{3r}{2\pi}$ from base

82 The polar moment of inertia of a circular section is—
   (A) $\frac{\pi D^2}{16}$ (B) $\frac{\pi D^3}{32}$
   (C) $\frac{\pi D^4}{32}$ (D) $\frac{\pi D^3}{64}$

83 The moment of inertia of a circular section about an axis X Y as compared to moment of inertia about axis Y Y is –
   (A) More (B) Less
   (C) Same (D) None of the above

84. The moment of inertia of a triangle about its base is –
(A) $\frac{bh^3}{12}$ (B) $\frac{bh^3}{24}$
(C) $\frac{bh^3}{36}$ (D) $\frac{bh^3}{48}$

85. The mass moment of inertia of a solid disc about the central axis is—
(A) $\frac{mR}{2}$ (B) $\frac{mR^2}{2}$
(C) $\frac{mR^3}{3}$ (D) $\frac{mR^2}{4}$

86. The angle of friction '$\phi$' given by the relation—
(A) $\text{Tan}\,\phi = \frac{R_n}{F}$
(B) $\text{Tan}\,\phi = R_n \times F$
(C) $\text{Tan}\,\phi = \frac{F}{R_n}$
(D) $\text{Tan}\,\phi = F - R_n$

87. The frictional force will—
(A) Always resist the motion of a body
(B) Accelerate the motion of body
(C) Neither resist nor accelerate the motion of a body
(D) Resist the motion of a body on a rough surface only

88. The coefficient of friction is given by the relation—
(A) $\mu = R_n \times F$ (B) $\mu = \frac{R_n}{F}$
(C) $\mu = R_n - F$ (D) $\mu = \frac{F}{R_n}$

89. One horse power is equal to—
(A) 764 watts (B) 746 watts
(C) 754 watts (D) 748 watts

90. Potential energy is due to the—
(A) Motion of a body
(B) Chemical reaction between two metals
(C) Fissioning of an atom
(D) Position of the body

91. The unit of work is –
(A) kg/cm$^2$ (B) kgm
(C) kg/sec$^2$ (D) kg/sec

92. One horse power is equal to—
(A) 75 kgf (B) 75 kgm
(C) 75 kg m/sec (D) 75 kg/m/sec

93. Work is defined as the product of—
(A) Force × acceleration
(B) Force × time
(C) Force × distance
(D) $\frac{\text{Force}}{\text{distance}}$

94 Watt is the unit of—
(A) Work
(B) Power
(C) Current
(D) Force

95. When the spring of a watch is wound, it will possess—
(A) Kinetic energy
(B) Heat energy
(C) Flow energy
(D) Potential energy

96. The time period of a seconds pendulum is—
(A) 1 second (B) 2 seconds
(C) $\frac{1}{2}$ second (D) $2\pi$ seconds

97. The length of seconds pendulum is equal to—
(A) 100 cm (B) 100 mts
(C) 99·39 cm (D) 99·39 cms

98. The number of vibrations per second is known as—
(A) Beat
(B) Amplitude
(C) Frequency
(D) Time period

99. The kinetic energy due to rotation is equal to—
(A) $I\omega^2$ (B) $\frac{I\omega^2}{2}$
(C) $\frac{I\omega}{2}$ (D) $\frac{I\omega^2}{4}$

100. The lathe bed is made of –
(A) Mild steel (B) Alloy steel
(C) Pig iron (D) Chilled cast iron

101. Drilling is an example of—
(A) Simple cutting (B) Orthogonal cutting
(C) Oblique cutting (D) None of these

102. In a shaper, the metal is removed during—
(A) Forward stroke
(B) Return stroke
(C) Both the forward and return stroke
(D) Neither the forward stroke nor the return stroke

103. D' Alembert's principle is used for—
(A) Reducing the problem of kinetics to equivalent statics problem
(B) Determining stresses in the truss
(C) Produce a moment of couple
(D) Stability of floating bodies

104. The centre of precussion of a solid cylinder of radius '$r$' resting on a horizontal plane will be—
(A) $\frac{r}{2}$ (B) $\frac{r}{4}$
(C) $\frac{2r}{3}$ (D) $\frac{3r}{2}$

105. Principal planes are the planes of—
(A) Maximum shearing stress
(B) Zero shearing stress
(C) Zero principal stress
(D) Minimum shearing stress

106. In case of pure bending the beam will bend into an arc of a—
(A) Parabola (B) Ellipse
(C) Hyperbola (D) Circle

107. The point of contrafexure occurs only in—
(A) Cantilever
(B) Overhanging beams
(C) Simply supported beams
(D) Continuous beams

108. Section modulus 'Z' is expressed as—
(A) $\frac{I}{y}$ (B) $\frac{M}{I}$
(C) M.I. (D) E.I.

109. A framed structure is perfect if it contains members equal to—
(A) $2n-3$ (B) $n-1$
(C) $2n-1$ (D) $3n-2$

110. The centre of gravity of a uniform lamina lies at—
(A) The centre of heavy portion
(B) The bottom surface
(C) The midpoint of its axis
(D) All of the above

## Answers

| | | | | |
|---|---|---|---|---|
| 1. (D) | 2. (D) | 3. (D) | 4. (D) | 5. (A) |
| 6. (B) | 7. (C) | 8. (C) | 9. (A) | 10. (D) |
| 11. (A) | 12. (C) | 13. (B) | 14. (A) | 15. (A) |
| 16. (C) | 17. (A) | 18. (C) | 19. (D) | 20. (B) |
| 21. (C) | 22. (A) | 23. (B) | 24. (D) | 25. (C) |
| 26. (A) | 27. (C) | 28. (C) | 29. (D) | 30. (B) |
| 31. (C) | 32. (B) | 33. (A) | 34. (C) | 35. (C) |
| 36. (B) | 37. (C) | 38. (C) | 39. (C) | 40. (C) |
| 41. (C) | 42. (C) | 43. (C) | 44. (C) | 45. (C) |
| 46. (B) | 47. (B) | 48. (B) | 49. (A) | 50. (C) |
| 51. (A) | 52. (C) | 53. (C) | 54. (B) | 55. (A) |
| 56. (B) | 57. (B) | 58. (D) | 59. (D) | 60. (A) |
| 61. (A) | 62. (C) | 63. (B) | 64. (C) | 65. (C) |
| 66. (C) | 67. (C) | 68. (A) | 69. (B) | 70. (C) |
| 71. (A) | 72. (C) | 73. (D) | 74. (B) | 75. (C) |
| 76. (C) | 77. (B) | 78. (B) | 79. (C) | 80. (D) |
| 81. (A) | 82. (C) | 83. (C) | 84. (A) | 85. (B) |
| 86. (C) | 87. (A) | 88. (D) | 89. (B) | 90. (D) |
| 91. (B) | 92. (C) | 93. (C) | 94. (B) | 95. (D) |
| 96. (B) | 97. (D) | 98. (C) | 99. (B) | 100. (D) |
| 101. (C) | 102. (A) | 103. (A) | 104. (D) | 105. (B) |
| 106. (D) | 107. (B) | 108. (A) | 109. (A) | 110. (C) |

# Model Set - 3

1. The path followed by the projectile is a—
   (A) Circle (B) Parabola
   (C) Hyperbola (D) Ellipse

2. The greatest height attained by the projectile is equal to—
   (A) $\frac{\mu^2 \sin^2 \alpha}{2g}$ (B) $\frac{\mu^2 \sin \alpha}{2g}$
   (C) $\frac{\mu^2 \sin^2 \alpha}{g}$ (D) $\frac{\mu \sin \alpha}{2g}$

3. When two colliding bodies before impact are moving along the line of compact, it is known as—
   (A) Oblique impact (B) Direct impact
   (C) Restitution (D) None of the above

4. The coefficient of restitution 'e' is always—
   (A) Equal to one (B) Less than one
   (C) More than one (D) None of the above

5. According to law of conservation of momentum—
   (A) Momentum before impact > momentum after impact
   (B) Momentum before impact < momentum after impact
   (C) Momentum before impact = momentum after impact
   (D) None of the above

6. Force is equal to—
   (A) Mass × density
   (B) Mass × acceleration
   (C) Mass × distance
   (D) Mass × velocity

7. The total momentum of two bodies after collision will—
   (A) Increase
   (B) Decrease
   (C) Remain constant
   (D) None of the above

8. A medium is said to be isotropic when—
   (A) ε is a scalar constant
   (B) ε is zero
   (C) ε is unity
   (D) ε is infinite

9. If a body moves vertically downwards, its—
   (A) Acceleration = $+g$
   (B) Acceleration = $-g$
   (C) Acceleration > $g$
   (D) Acceleration < $g$

10. The acceleration in a cartesian system is expressed as—
   (A) $\tan^{-1} \frac{a_x}{a_y}$ (B) $\tan^{-1} \frac{a_y}{a_x}$
   (C) $\cot^{-1} \frac{a_x}{a_y}$ (D) $\sin^{-1} \frac{a_x}{a_y}$

11. The velocity ratio of a differential pulley is—
   (A) $\frac{2D}{D-d}$ (B) $\frac{D}{D-d}$
   (C) $\frac{D}{2(D-d)}$ (D) $\frac{2(D-d)}{D}$

12. The value of modulus of elasticity for mild steel is—
   (A) $2 \times 10^6$ kgf/cm
   (B) $1 \times 10^6$ kgf/cm$^2$
   (C) $0{\cdot}5 \times 10^6$ kgf/cm$^2$
   (D) $0{\cdot}05 \times 10^6$ kgf/cm$^2$

13 In an ideal machine—
   (A) Work done = Velocity ratio
   (B) Work done > Velocity ratio
   (C) Work done < Velocity ratio
   (D) None of the above

14. The efficiency of a reversible machine should be more than—
   (A) 40% (B) 50%
   (C) 80% (D) 95%

15. If the efficiency of a machine is less than 50%, it is known as –
    (A) Reversible machine
    (B) Self locking machine
    (C) Ideal machine
    (D) None of the above

16. In first system of pulleys, the velocity ratio is equal to—
    (A) $2 \times n$ (B) $2n$
    (C) $\frac{2}{n}$ (D) $2 + n$

17. The acceleration of a body can be expressed as—
    (A) $\frac{dV}{dt}$ (B) $\frac{d^2s}{dt^2}$
    (C) V/t (D) All of the above

18. Hooke's Law states that within the elastic limit—
    (A) Stress + Strain = Constant
    (B) Stress – Strain = Constant
    (C) Stress × Strain = Constant
    (D) $\frac{\text{Stress}}{\text{Strain}}$ = Constant

19 The value of Poisson's ratio $\left(\frac{1}{m}\right)$ is never greater than—
    (A) 0·05 (B) 0·5
    (C) 1·5 (D) 5·0

20 In radar system, the pulses are sent at—
    (A) A regular time
    (B) A regular interval
    (C) Any interval
    (D) None of these

21. The maximum value of tangential stress from Mohr circle diagram, is equal to—
    (A) Radius of the circle
    (B) Diameter of the circle
    (C) Half of the radius
    (D) None of the above

22. Mohr's circle is used as a graphical method for analysis of—
    (A) Simple stress
    (B) Two dimensional stress
    (C) Combined bending moment and torsion
    (D) Shear force and bending moment

23. The quantity of strain energy stored in a material without any permanent deformation is known as—
    (A) Resilience
    (B) Proof resilience
    (C) Modulus of resilience
    (D) None of the above

24. A beam having more than two supports is called as—
    (A) Fixed beam
    (B) An overhanging beam
    (C) Continuous beam
    (D) Simply supported beam

25. The diaphram of an earphone vibrates due to varying ..... produced by the coil—
    (A) Electric charge
    (B) Poles
    (C) Magnetic flux
    (D) None of these

26. The bending equation is given as—
    (A) $\frac{M}{I} = \frac{f}{R} = \frac{E}{y}$ (B) $\frac{M}{I} = \frac{f}{y} = \frac{E}{R}$
    (C) $\frac{M}{y} = \frac{R}{I} = \frac{E}{f}$ (D) $\frac{M}{I} = \frac{y}{E} = \frac{f}{R}$

27. The most economical mild steel section is—
    (A) I section
    (B) Circular section
    (C) Rectangular section
    (D) Channel section

28. A beam will have uniform strength if—
    (A) Its cross-sectional area is same throughout the beam
    (B) The shear stress is same at every section of the beam
    (C) The bending stress is same at every section of the beam
    (D) None of the above

29. The bending stress in a beam is—
    (A) Equal to bending moment
    (B) Less than bending moment
    (C) Directly proportional to the bending moment
    (D) Inversely proportional to the bending moment

30. The ratio of maximum deflection of a beam to its span is called —
(A) Strain (B) Poisson's ratio
(C) Suffness (D) Safety factor

31. Characteristic impedance is a fine and useful concept of a—
(A) Circuit (B) Transmission
(C) Network (D) None of these

32. The anode material is usually made of—
(A) Carbon (B) Nickel
(C) Copper (D) None of these

33. The laminated spring is supported at the—
(A) Centre
(B) Both ends
(C) One end only
(D) Centre as well as both ends

34. The type of spring used in clutches of automobiles is—
(A) Laminated spring
(B) Spiral spring
(C) Closed coiled helical spring
(D) Disc spring

35. Hoop or circumferential stress is equal to—
(A) Longitudinal stress
(B) Twice the longitudinal stress
(C) Half of the longitudinal stress
(D) Four times the longitudinal stress

36. The pitch of riveted joint is generally—
(A) $\frac{d}{2}$ (B) $2d$
(C) $3d$ (D) $1.5d$

37. For general stress calculation a cylinder is considered thin, if—
(A) $\frac{t}{d} \leq 0.05$ (B) $\frac{t}{d} \leq 0.5$
(C) $\frac{t}{d} \leq 5.0$ (D) $\frac{t}{d} \leq 0.025$

38. A link must be a—
(A) Rigid body
(B) Resistant body
(C) Rigid as well as resistant body
(D) None of the above

39. When motion is transmitted by means of a fluid it is known as –
(A) Flexible link (B) Rigid link
(C) Fluid link (D) None of the above

40 Flat belt running over a pulley forms—
(A) A closed pair (B) An open pair
(C) A spherical pair (D) A screw pair

41. A kinematic chain should have a minimum of—
(A) One link (B) Two links
(C) Three links (D) Four links

42 The three types of links are—
(A) Cross, rigid & fluid
(B) Rigid, elastic & fluid
(C) Rigid, flexible & fluid
(D) Strength, rigid & flexible

43 In a compound kinematic chain the number of pairs are more than—
(A) Two (B) Three
(C) Four (D) Six

44. In slider crank chain the number of possible inversions are—
(A) Three (B) Four
(C) Five (D) Six

45 The double slider crank chain consists of—
(A) Two turning and two sliding pairs
(B) One turning and one sliding pairs
(C) Two turning and one sliding pairs
(D) Three turning pairs

46. The angular acceleration is equal to—
(A) $\frac{d\theta}{dt}$ (B) $\frac{ds}{dt}$
(C) $\frac{d\omega}{dt}$ (D) $\frac{d\omega}{d\theta}$

47 The unit for angular acceleration is
(A) Metre/sec (B) Metre/sec$^2$
(C) Radians/sec$^2$ (D) Rad/sec

48. The slope of velocity-time curve represents—
(A) Displacement (B) Acceleration
(C) Velocity (D) None of the above

49. Angular acceleration of a body is—
(A) The rate of change of displacement
(B) The rate of change of velocity
(C) The rate of change of angular velocity
(D) The rate of change of momentum

50. Inertia force is equal to—
(A) $mv$ (B) $-mv$
(C) $-mf$ (D) $Wf$

51. The ratio of tensions in the tight and slack sides of a belt is given by the relation—
(A) $\frac{T_1}{T_2} = e^{\mu\theta}$ (B) $\frac{T_1}{T_2} = e^{\theta}$
(C) $\frac{T_1}{T_2} = e^{2\mu\theta}$ (D) $\frac{T_1}{T_2} = \mu e^{\theta}$

52. The circular pitch is equal to—
(A) $\frac{T}{D}$ (B) T.D
(C) $\frac{D}{T}$ (D) $\frac{\pi D}{T}$

53 The pressure angle for gear teeth is in the range of—
(A) 0°—10° (B) 10°—15°
(C) 15°—20° (D) 25°—40°

54. The fractional torque in a flat pivot bearing for a uniformly distributed pressure is—
(A) $\mu Wr$ (B) $\frac{3}{2}\mu Wr$
(C) $\frac{2}{3}\mu Wr$ (D) $\frac{1}{4}\mu Wr$

55. The maximum fluctuation of energy of a flywheel is equal to—
(A) $I\omega(\omega_1 - \omega_2)$ (B) $\frac{I\omega(\omega_1 - \omega_2)}{g}$
(C) $I\omega^2(\omega_1 - \omega_2)$ (D) $\frac{I(\omega_1 - \omega_2)}{\omega}$

56. Sensitiveness of a governor is equal to—
(A) $\frac{N}{N_1 - N_2}$ (B) $\frac{N_1 - N_2}{N}$
(C) $\frac{N_1 + N_2}{N}$ (D) $\frac{N}{N_1 + N_2}$

57. The primary accelerating force acting on a reciprocating piston is equal to—
(A) $\frac{R}{g}\omega^2 r\cos\theta$ (B) $\frac{g}{R}\omega^2 r\cos\theta$
(C) $\frac{R}{g}\omega r\cos\theta$ (D) $\frac{g}{R}\omega r\cos\theta$

58 The shearing resistance for a rivet in double shear according to I.B.R. is equal to—
(A) $2 \times \frac{\pi d^2}{4} \times f_s$ (B) $2{\cdot}5 \times \frac{\pi d^2}{4} \times f_t$
(C) $1{\cdot}875 \times \frac{\pi d^2}{4} \times f_c$ (D) $1{\cdot}5 \times \frac{\pi d^2}{4} \times f_c$

59 The included angle for the B.S.W. thread is—
(A) 55° (B) 45°
(C) 35° (D) 65°

60. The efficiency of the square threads is given by the expression—
(A) $\eta = \frac{\tan(\phi \pm \alpha)}{\tan\alpha}$ (B) $\eta = \frac{\tan\alpha}{\tan(\phi + \alpha)}$
(C) $\eta = \frac{\tan\alpha}{\tan\phi}$ (D) $\eta = \frac{\tan\phi}{\tan\alpha}$

61 When a shaft is subjected to combined bending and torsion, the equivalent bending moment is equal to—
(A) $M_e = \frac{1}{2}\left(M + \sqrt{M + T}\right)$
(B) $M_e = \frac{1}{2}\left(M + \sqrt{M^2 + T^2}\right)$
(C) $M_e = \frac{1}{2}\left(M^2 + \sqrt{M^2 + T^2}\right)$
(D) $M_e = \frac{1}{2}\left(M + \sqrt{M^2 - T^2}\right)$

62. The thickness of spherical shell is given by the relation—
(A) $t = \frac{pD}{4f\eta}$ (B) $t = \frac{pD}{2f\eta}$
(C) $t = \frac{2pD}{f\eta}$ (D) $t = \frac{4pD}{f\eta}$

63. The storage capacity of spherical shell is equal to—
(A) $\frac{\pi}{4}D$ (B) $\frac{\pi}{4}D^2$
(C) $\frac{\pi}{6}D^2$ (D) $\frac{\pi}{6}D$

64. The velocity, at which the maximum horse power is transmitted is given by—

(A) $V = \sqrt{\frac{T}{3W}}$ (B) $V = \frac{\sqrt{g}T}{3W}$

(C) $V = \sqrt{\frac{2g}{3W}T}$ (D) $V = \sqrt{\frac{g}{3W}T}$

65. The minimum face width of a helical gears's tooth is—

(A) $\frac{p}{\sin\alpha}$ (B) $\frac{p}{\cos\alpha}$

(C) $p\sin\alpha$ (D) $\frac{p}{\tan\alpha}$

66. Thermal power plant works on—

(A) Rankine cycle

(B) Otto cycle

(C) Joule cycle

(D) Constant pressure cycle

67. The number of teeth on the smaller sprocket of silent chain drive should preferably be not less than—

(A) 10 (B) 12

(C) 15 (D) 17

68. The depth of centre of pressure (h) is given by the relation—

(A) $h = I_0 A\bar{X}$ (B) $h = \frac{I_0}{A\bar{X}}$

(C) $h = \frac{I_0\bar{X}}{A}$ (D) $h = \frac{I_0 A}{\bar{X}}$

69. The strain energy stored by the liquid in compression is equal to—

(A) $\frac{P^2}{2K} \times$ volume

(B) $\frac{P}{2K} \times$ volume

(C) $\frac{2P^2}{K} \times$ volume

(D) $2P^2 \times K \times$ volume

70. The relation between coefficient of discharge, coefficient of velocity and coefficient of contraction is given as—

(A) $C_d = C_v \times C_c$ (B) $C_d = C_v - C_c$

(C) $C_d = \frac{C_v}{C_c}$ (D) $C_v = C_d \times C_c$

71. The loss of head at entrance in a pipe is equal to –

(A) $\frac{0{\cdot}5v^2}{2g}$ (B) $\frac{0{\cdot}5v}{2g}$

(C) $\frac{1{\cdot}5v^2}{2g}$ (D) $0{\cdot}5v^2$

72 Loss of head due to sudden enlargement is equal to—

(A) $\frac{(V_1 - V_2)^2}{g}$ (B) $\frac{(V_1 - V_2)^2}{2g}$

(C) $\frac{V_1 - V_2}{2g}$ (D) $\frac{V_1^2 - V_2^2}{2g}$

73 The dimensions of C in the Chezy's formula are—

(A) $L^{1/2}T$ (B) $L^2T$

(C) $L^{1/2}T^{-1}$ (D) $L^{-1}T^{1/2}$

74 The kinematic viscosity '$\epsilon$' is given by the relation—

(A) $\epsilon = \frac{\eta}{p}$ (B) $\epsilon = \eta p$

(C) $\epsilon = \frac{p}{\eta}$ (D) $\epsilon = p + \eta$

75 The Darcy equation is expressed as—

(A) $h_f = \frac{f_1}{d} \cdot \frac{v^2}{2g}$ (B) $h_f = \frac{4f_1}{d} \cdot \frac{v^2}{2g}$

(C) $h_f = \frac{4f_1}{d} \times \frac{v^2}{2g}$ (D) $h_f = \frac{4f_1}{d} \times \frac{v}{g}$

76 The wetted perimeter for a pipe running full of water is equal to—

(A) $\frac{\pi d}{2}$ (B) $2\pi d$

(C) $\pi d$ (D) $\frac{\pi}{4}d^2$

77. The hydraulic mean depth for a pipe running fall of water is equal to—

(A) $\frac{d}{2}$ (B) $\frac{d}{4}$

(C) $2d$ (D) $2\pi d$

78. The critical depth of a channel is expressed as

(A) $h_c = \frac{v}{g}$ (B) $h_c = \frac{v^2}{g}$

(C) $h_c = \frac{v^2}{2g}$ (D) $h_c = \frac{1}{2}\frac{mv}{2g}$

79. The relation between kinetic head and the minimum specific energy is—

(A) $\frac{v_c^2}{2} = \frac{1}{3} E_{min}$

(B) $\frac{v_c^2}{2g} = \frac{2}{3} E_{min}$

(C) $\frac{v_c^2}{2g} = \frac{1}{4} E_{min}$

(D) $\frac{v_c^2}{2g} = \frac{3}{2} E_{min}$

80. The unit power of a turbine is equal to—

(A) $\frac{P}{H^{5/2}}$ (B) $\frac{P}{H^{1/2}}$

(C) $\frac{P}{H^{3/2}}$ (D) $\frac{P}{H^{1/3}}$

Where, P = Horse power developed

81. The specific speed of a centrifugal pump is given as—

(A) $\frac{N\sqrt{Q}}{h^{1/2}}$ (B) $\frac{N\sqrt{Q}}{h^{3/4}}$

(C) $\frac{N\sqrt{Q}}{h^{5/4}}$ (D) $\frac{N\sqrt{Q}}{h^{3/2}}$

82. One constituent of carbide tool is tungsten carbide. The other constituent is—

(A) Vanadium
(B) Chromium
(C) Aluminium oxide
(D) Cobalt

83. The percentage of carbon of grey cast iron is in the range of—

(A) 3·0 to 3·5 (B) 2·0 to 2·5
(C) 1·0 to 1·5 (D) 0·5 to 1·0

84. The product obtained from puddling is known as—

(A) Cast-Iron (B) Pig Iron
(C) Wrought Iron (D) Carbon steel

85. The melting point of iron is—

(A) 1810°C (B) 1620°C
(C) 1539°C (D) 1648°C

86. The molten form of iron is known as—

(A) Alpha Iron (B) Gamma Iron
(C) Delta Iron (D) None of these

87. The maximum percentage of carbon in steel is—

(A) 2·5% (B) 1·5%
(C) 0·85% (D) 0·5%

88 The hypo steel after normalisation consists of—

(A) Ferrite and cementite
(B) Ferrite and mertensite
(C) Ferrite and pearlite
(D) Pearlite and cementite

89 The depth of hardness obtained by induction hardening varies from—

(A) 2·8 to 2·5 mm
(B) 0·1 to 0·8 mm
(C) 0·01 to 0·02 mm
(D) 1·0 to 1·8 mm

90. Bronze in an alloy of—

(A) Copper and Tin
(B) Copper and Aluminium
(C) Copper and lead
(D) Copper and zinc

91 Steam condenser tubes are made of—

(A) Alnico
(B) Bell metal
(C) Duralumin
(D) Admiralty brass

92. Pewter is an alloy of—

(A) Tin and Lead
(B) Tin and Aluminium
(C) Lead and Zinc
(D) Lead and Nickel

93. Which one is more ductile ?

(A) Lead (B) Copper
(C) Tin (D) Gold

94. The specification, Sn 10 Sb 14 Pb indicate antification bearing alloy of grade—

(A) 10 (B) 14
(C) 90 (D) 75

95. Conel is a—

(A) Copper base alloy
(B) Tin base alloy
(C) Nickel base alloy
(D) Aluminium base alloy

96. Invar steel contains –
(A) 20% Nickel
(B) 36% Nickel
(C) 48% Nickel
(D) 5% Nickel

97. The specific gravity of plastic to increase the property of moulding and resistance to heat are—
(A) 1·3 to 1·4
(B) 3·1 to 3·5
(C) 0·5 to 0·8
(D) 0·8 to 1·05

98. The Carnot efficiency is given by the relation—
(A) $\frac{T_1 + T_2}{T_1 - T_2}$
(B) $\frac{T_1 - T_2}{T_1 + T_2}$
(C) $\frac{T_1 - T_2}{T_1}$
(D) $\frac{T_1}{T_1 - T_2}$

99 For calculating air standard efficiency the working fluid is—
(A) Diesel (B) Petrol
(C) Air (D) Steam

100 Gas turbine works on—
(A) Constant volume cycle
(B) Otto cycle
(C) Ericsson cycle
(D) Joule cycle

101. Bending moment at any point is equal to the algebraic sum of—
(A) All vertical forces
(B) All horizontal forces
(C) Forces on either side of the point
(D) Moments of forces on either side of the point

102 Shear force at any point on the beam is algebraic sum of—
(A) All vertical forces
(B) All horizontal forces
(C) Forces on either side of the point
(D) Moments of forces on either side of the point

103. The point of contraflexure is a point where—
(A) Shear force is zero
(B) Shear force changes sign
(C) Bending moment changes sign
(D) Bending moment is maximum

104. The maximum shear stress in Mohr's circle will be at following angles to the principle plane—
(A) 0° (B) 45°
(C) 60° (D) 90°

[illegible]. Mercury is used in barometers on account of its—
(A) Negligible capillary effect
(B) High density
(C) Very low vapour pressure
(D) Low compressibility

106. Standard atmosphere in terms of water column is—
(A) 9·81 m
(B) 10·33 m
(C) 8·9 m
(D) 12·75 m

107 An ideal fluid is the one which—
(A) Is compressible
(B) Is incompressible
(C) Has low density
(D) Is non-viscous and incompressible

[illegible] The stagnation pressure is the sum of—
(A) Static pressure and vacuum pressure
(B) Dynamic pressure and vacuum pressure
(C) Static pressure and dynamic pressure
(D) Absolute pressure and dynamic pressure

109 A substance above critical temperature exists as—
(A) Supersaturated fluid
(B) Gas
(C) Liquid
(D) Vapour

[illegible] The value of entropy at 0°C is taken as—
(A) 1
(B) Zero
(C) – 1
(D) Some other value

## Answers

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. (B) | 2. (A) | 3 (B) | 4 (B) | 5. (C) | 56. (A) | 57. (B) | 58 (C) | 59 (A) | 60. (B) |
| 6. (B) | 7. (C) | 8 (A) | 9 (A) | 10 (B) | 61 (B) | 62. (A) | 63. (C) | 64 (B) | 65. (D) |
| 11. (A) | 12. (A) | 13. (A) | 14 (B) | 15. (B) | 66. (A) | 67. (D) | 68 (B) | 69 (A) | 70. (A) |
| 16. (B) | 17. (D) | 18. (D) | 19 (B) | 20. (B) | 71. (A) | 72. (B) | 73 (A) | 74 (A) | 75 (B) |
| 21. (A) | 22. (B) | 23 (B) | 24 (C) | 25. (C) | 76. (C) | 77. (A) | 78 (A) | 79. (A) | 80. (C) |
| 26. (B) | 27. (A) | 28 (C) | 29 (C) | 30. (C) | 81. (B) | 82. (D) | 83. (A) | 84 (C) | 85 (C) |
| 31. (B) | 32. (B) | 33 (A) | 34 (C) | 35. (B) | 86. (D) | 87. (B) | 88 (C) | 89 (B) | 90. (A) |
| 36. (B) | 37. (A) | 38 (B) | 39 (C) | 40. (B) | 91. (D) | 92. (A) | 93. (D) | 94 (A) | 95. (C) |
| 41. (D) | 42. (C) | 43 (C) | 44 (B) | 45. (A) | 96. (B) | 97. (A) | 98. (C) | 99 (C) | 100. (C) |
| 46. (C) | 47. (B) | 48 (B) | 49 (C) | 50. (C) | 101. (D) | 102. (C) | 103. (C) | 104. (D) | 105. (C) |
| 51. (D) | 52. (C) | 53 (C) | 54 (C) | 55. (A) | 106. (B) | 107. (D) | 108. (C) | 109. (A) | 110. (B) |

# Model Set - 4

1. As the shear angle increases, the plastic deformation of chip—
   (A) Increases (B) Decreases
   (C) Remains same (D) None of these
2. The type of chip obtained by machining hard and brittle metals is—
   (A) Continuous chip with built up edge
   (B) Continuous chip
   (C) Discontinuous chip
   (D) Inhomogeneous chip
3. In oblique cutting, the angle at which the cutting face is inclined to the direction of the cut is—
   (A) 45° (B) 90°
   (C) 30° (D) 60°
4. In broaching steel parts in the from of chips obtained are—
   (A) Short helices (B) Long helices
   (C) Closed spirals (D) Fragments
5 With the increase in cutting speed—
   (A) The tool cutting force increases
   (B) The tool cutting force decreases
   (C) The tool cutting force remains more or less constant
   (D) None of the above
6. A tool may fail due to—
   (A) Plastic deformation of cutting edge
   (B) Cracking of cutting edge
   (C) Flank wear
   (D) None of the above
7. The tool life is expressed by the relation—
   (A) $VT^b = C$ (B) $\frac{V}{T} = C$
   (C) $\frac{V}{T^b} = C$ (D) $Vb\,T = C$
8. Which of the following factors has maximum influence on tool life ?
   (A) Shape and angle of tool
   (B) Tool material
   (C) Cutting speed
   (D) Nature of coolant
9 The matching time is proportional to—
   (A) V (B) $V^2$
   (C) $\frac{1}{V}$ (D) $\frac{1}{V^2}$
10 In case of high speed steel tool, the increase in tool life with the use of cutting fluid is—
   (A) 60% (B) 50%
   (C) 25% (D) 10%
11 In matching the thickness of the chip produced as compare to the depth of cut is—
   (A) Less
   (B) More
   (C) Same
   (D) May be less or more depending upon the material of the tool
12 With the increase in depth of cut the tool cutting force—
   (A) Increases (B) Decreases
   (C) Remains same (D) Unpredictable
13 The side rake angle of high speed steel tool for machining brass is—
   (A) 15° (B) 12°
   (C) 8° (D) 0°
14 Cutting forces at the cutting tool can be measured by—
   (A) A dynamometer
   (B) A viscometer
   (C) A sine bar
   (D) A combination set
15 The cutting angle of tool for machining brass is
   (A) 50° (B) 60°
   (C) 84° (D) 95°

16. The crater wear of tool is due to –
    (A) The abrading action of the chip
    (B) The rubbing of tool against the work piece
    (C) The chemical action of the coolant
    (D) The excessive heat produced during cutting

17. Which of the following is a single point cutting tool ?
    (A) Hacksaw blade (B) Milling cutter
    (C) Grinding wheel (D) None of the above

18. Cold working of metals is carried out—
    (A) Above the lower critical temperature
    (B) Above the higher critical temperature
    (C) Below the lower critical temperature
    (D) Between the higher and lower critical temperature

19. Extrusion is the process of—
    (A) Pushing the heated billet of metal through an office
    (B) Producing a hole by using a punch
    (C) Making cup shaped parts from the sheet metal
    (D) None of the above

20. The operation of cutting holes in sheet by a press is known as—
    (A) Trimming (B) Slitting
    (C) Perforating (D) Punching

21. The cold working of metals results in—
    (A) Decrease of strength
    (B) Refined grain structure
    (C) Increase of strength and hardness of metal
    (D) Increase in ductility

22. Cold working results in—
    (A) Increase of ductility of metal
    (B) Increase of strength and hardness of metal
    (C) Decrease of strength and hardness of metal
    (D) Refine of grain structure

23. The process used for producing flutes or corrugation is known as—
    (A) Crimping (B) Coining
    (C) Hobbing (D) Stamping

24. The process of producing seamless tubes is known as –
    (A) Piercing (B) Cupping
    (C) Bending (D) Drawing

25 A press of 50 tonnes capacity means that—
    (A) Its weight is 50 tonnes
    (B) Its total output per hour is 50 tonnes
    (C) Its maximum load applying capacity is 50 tonnes
    (D) None of the above

26 Blanking is the operation of—
    (A) Cutting of flat sheet to the desired shape
    (B) Production of number of holes evenly spaced in a regular pattern on a sheet metal
    (C) Formation of hole
    (D) Cutting a sheet metal in two parts

27. The process of printing letters and numbers on metal sheet is known as—
    (A) Hobbing (B) Coining
    (C) Stamping (D) Crimping

28. The operation of shaping thin sheets by pressing them against a form is known as—
    (A) Crimping (B) Spinning
    (C) Stamping (D) Lamening

29. Thick walled tubes or cylinder are produced by—
    (A) Drawing heated plates
    (B) Hot spinning of metal
    (C) Stamping sheet metal
    (D) Press forming

30. The surface finish of parts produced by hot working process as compared to cold working process is—
    (A) Poor (B) Better
    (C) Same (D) None of these

31 A progressive dieper forms—
    (A) Only one operation at each stroke of the ram
    (B) Two or more operations at different stations of the press
    (C) Two or more operations at one station of the press
    (D) All of the above

32. In thermit welding the high temperature is produced by —
    (A) An electric arc
    (B) An exothermal chemical reaction
    (C) The combustion of oxygen and acetylene
    (D) None of the above

33. The type of flame used for welding and cutting operation is—
    (A) Reducing flame
    (B) Neutral flame
    (C) Oxidizing flame
    (D) None of the above

34. The flame produced with excess of oxygen in gas welding is known as—
    (A) Carbonizing flame
    (B) Neutral flame
    (C) Reducing flame
    (D) Oxidizing flame

35. The type of flame used for welding nickel metal is—
    (A) Neutral (B) Reducing
    (C) Oxidizing (D) None of the above

36. The strength of the joint is more in case of—
    (A) Welding (B) Soldering
    (C) Brazing (D) None of these

37. The method of joining metal surfaces by introducing a non ferrous alloy with melting point 400°C is known as—
    (A) Soldering (B) Brazing
    (C) Welding (D) None of the above

38 The angle of torch in case of backhand type gas welding is—
    (A) 10 degree to 15 degree
    (B) 15 degree to 25 degree
    (C) 40 degree to 50 degree
    (D) 60 degree to 70 degree

39. Which of the following gas for heating is prepared for soldering and brazing ?
    (A) Oxy acetylene (B) Oxy hydrogen
    (C) Air acetylene (D) None of the above

40. The ultrasonic welding is suitable for metal up to—
    (A) 3 mm thick (B) 5 mm thick
    (C) 8 mm thick (D) 10 mm thick

41. In laser welding the heat is supplied by —
    (A) The oxy-acetylene gas
    (B) The electric arc
    (C) The collimated light beam
    (D) Inducing the current

42 Which of the following process is used for cutting and welding of non-ferrous metals ?
    (A) Carbon arc welding
    (B) Inert gas arc welding
    (C) Submerged arc welding
    (D) Metal arc welding

43 Which of the alloy is used for brazing ?
    (A) Copper alloy
    (B) Silver alloy
    (C) Aluminium alloy
    (D) Any of the above

44. Wipping is the process of making connection of lead pipes with the help of a—
    (A) Soldering alloy
    (B) Brazing alloy
    (C) Tungston electrode
    (D) Carbon electrode

45 Blow holes in a casting are caused by—
    (A) Excessive ramming and improper venting of mould sand
    (B) Insufficient ramming of mould sand
    (C) Incomplete filling of mould
    (D) Contraction of the metal during solidification

46. The defect in a casting due to insufficient ramming of mould sand is known as—
    (A) Shrinkage (B) Blow holes
    (C) Swell (D) Scab

47 The tool used or lifting the pattern from the mould is called—
    (A) Trowel (B) Slick
    (C) Lifter (D) Draw spikes

48. The defect in casting due to incomplete filling of mould is known as—
    (A) Shrinkage (B) Swell
    (C) Pour short (D) Honey-combing

49. Casting is the process used primarily—
    (A) To change the shape of metals
    (B) For machining parts to planned dimensions

(C) To obtain a surface finish
(D) In joining parts or materials

50. The vertical passage for bringing the molten metal to mould cavity is known as a—
(A) Gate (B) Sprue
(C) Riser (D) Runner

51. The amount of draft allowance provided on the exterior surface of pattern is up to—
(A) 2 mm for 100 mm
(B) 5 mm for 100 mm
(C) 10 mm for 100 mm
(D) 0·5 mm for 100 mm

52. Which of the following material is used for making of pattern ?
(A) Aluminium (B) Plastics
(C) Mercury (D) All of the above

53. The taper provided an all vertical surfaces of a pattern is known as—
(A) Shrinkage allowance
(B) Draft allowance
(C) Machining allowance
(D) Distortion allowance

54 The amount by which a pattern is made oversize to compensate for the contraction of casting is called as—
(A) Shrinkage allowance
(B) Draft allowance
(C) Rapping allowance
(D) Machining allowance

55. The single-point cutting tool is used in—
(A) Milling work (B) Broaching work
(C) Reaming work (D) Lathe work

56. The most important factor for specifying the lathe machine is—
(A) The maximum diameter of the work it will swing
(B) The length of bed
(C) The maximum speed of the spindle
(D) Height of the bed

57 The operation of bevelling the extreme end of a work piece is known as—
(A) Chamfering (B) Knurling
(C) Spinning (D) Facing

58. Knurling is the process of –
(A) Bevelling the extreme end of a work-piece
(B) Embossing a diamond shaped pattern on the surface of a workpiece
(C) Machining the ends of a work piece
(D) Finishing a hole which has been previously drilled

59. The mandrel is used—
(A) For holding and rotating a hollow piece of work on the lathe
(B) For drilling hole in a workpiece
(C) As a taper turning attachment on the lathe machine
(D) For checking the furnished

60. In a shaper tool the side clearance angle is—
(A) 10 degree to 15 degree
(B) 15 degree to 18 degree
(C) 5 degree to 10 degree
(D) 2 degree to 3 degree

61 In a planer, the ratio of cutting time to return time is—
(A) 5 : 1 to 7 : 1 (B) 2 : 1 to 4 : 1
(C) 6 : 1 to 8 : 1 (D) 1 : 1 to 1·5 : 1

62. A 3000 mm planner indicates that—
(A) The length of the table is 3000 mm
(B) The maximum length of table travel is 3000 mm
(C) The distance between the two housing is 3000 mm
(D) None of the above

63. In a nailing operation—
(A) The work is fed against a reciprocating tool
(B) The work is fed against a rotating multi-point cutter
(C) The tool is fed against a rotating work
(D) The tool is fed against reciprocating work

64. The helix angle for a milling cutter is in the range of—
(A) 25 degree to 45 degree
(B) 35 degree to 60 degree
(C) 10 degree to 15 degree
(D) 5 degree to 10 degree

65. In upmilling the cutter rotates—
(A) Against the same direction of travel of the workpiece
(B) In the same direction of travel of the workpiece
(C) Against the stationary workpiece
(D) None of the above

66. The shaper is used for machining of—
(A) Flat surfaces
(B) Cylindrical surface
(C) Spherical surfaces
(D) All of the above

67. The machine used for machining flat surfaces of large size is—
(A) Lathe (B) Milling
(C) Planer (D) Shaper

68. Tapping is the operation of—
(A) Cutting external threads
(B) Cutting internal threads
(C) Finishing the flat surfaces
(D) Enlarging the end of hole

69 The process of enlarging a hole is known as—
(A) Counter boarding
(B) Countersinking
(C) Boring
(D) Drilling

70. The usual value of lip clearance angle of a drill is—
(A) 25° (B) 30°
(C) 12° (D) 5°

71 The velocity of jet of water from orifice is given by—
(A) $V = 2gH$ (B) $V = \sqrt{2gH}$
(C) $V = \frac{1}{2\sqrt{gH}}$ (D) $V = \frac{\sqrt{2}}{gH}$

72. In radial drilling machine—
(A) It is not possible to raise the radial arm
(B) It is not possible to lower the radial arm
(C) It is possible to tilt the radial arm
(D) The radial arm can be swung around the vertical

73 The usual point angle for twist drill is—
(A) 45° (B) 60°
(C) 118° (D) 160°

74. Twist drills are generally made of –
(A) High speed steel
(B) Mild steel
(C) Aluminium alloy
(D) Bronze

75 Which is manufactured by abrasive material ?
(A) Sand stone (B) Diamond
(C) Silicon carbide (D) Garnet

76 The raw material used for manufacturing aluminium oxide as abrasive material is—
(A) Silica sand (B) Bauxite
(C) Quartz (D) Silicon carbide

77. A grinding wheel is specified as WA 46 WS VBE. The number 46 denotes
(A) Grain size
(B) Structure of wheel
(C) Diameter of wheel in centimetres
(D) Surface speed

78. The grinding ratio normally varies from—
(A) 10 to 25 (B) 25 to 50
(C) 75 to 125 (D) 150 to 300

79. The grinding wheel is considered better if the grinding ratio is—
(A) Maximum (B) Very low
(C) Average (D) Minimum

80. The speed used for super finishing varies from—
(A) 1800 to 3000 S. m.p.m
(B) 1000 to 2000 S. m.p.m
(C) 1 to 15 S. m.p.m
(D) 500 to 1000 S. m.p.m

81 The amount of material removed by the process of super finishing is about—
(A) 0·2 mm (B) 0·02 mm
(C) 0·002 mm (D) 0·5 mm

82. The surface speed for tool and cutter grinding is in the range of—
(A) 600 to 800 m/min
(B) 800 to 1000 m/min
(C) 1500 to 2000 m/min
(D) 2500 to 3000 m/min

83. The factor on which selection of grinding wheel depends upon—
(A) Material to be ground
(B) Amount of stock to be removed
(C) Area of contact
(D) All of the above

84. The term grade as applied to grinding wheel refers to—
(A) The size of the grains
(B) The tenacity or hardness with which the bond holds the cutting points or abrasive grains
(C) The size of the grinding wheel
(D) None of the above

85. The grit size for surface grinding is—
(A) 10-12 (B) 12-15
(C) 15-25 (D) 40-60

86. The average frequency of sparks in electro-discharge machining is—
(A) 500 sparks/sec (B) 1000 sparks/sec
(C) 5000 sparks/sec (D) 10000 sparks/sec

87. In electro-discharge machining (EDM), the material of tool is—
(A) High speed steel (B) Brass or copper
(C) Carbide (D) Diamond

88 In electron beam machining the erosion of metal is achieved by—
(A) A high velocity focussed stream of electrons
(B) The rapidly occuring sparks between the workpiece and the tool
(C) The high frequency of abrasive particles
(D) None of the above

89 The gap between the anode and the cathode of an electro chemical milling is about—
(A) 0·025 cm (B) 0·25 cm
(C) 2·5 cm (D) 1·5 cm

90. The metal removing rate of electro-chemical machining as compared to electro discharge machining is—
(A) More (B) Less
(C) Same (D) None of these

91. The appearance of laser beam is—
(A) Greenish (B) Reddish
(C) Yellowish (D) Whitish

92 The numerical control machine, servomotor is operated by converting information recorded on punched tape into—
(A) Bound signals
(B) Light signals
(C) Electrical signals
(D) Mechanical signals

93. When normal depth is equal to critical depth, the profile made by a free water surface is called—
(A) H profile (B) S profile
(C) C profile (D) A profile

94 In case of most economical section of triangular channel. The included angle between the equal sloping sides is equal to—
(A) 45° (B) 90°
(C) 30° (D) 60°

95. The amount of discharge in case of adhering nappe as compared to free nappe over the weir as—
(A) More (B) Less
(C) Same (D) Unpredictable

96. The Bernoulli's theorem for liquid is applicable for—
(A) Turbulent flow
(B) Viscous fluids
(C) Compressible fluids
(D) None of the above

97. The flow between two parallel flat plates, one in motion and the other at rest, is known as—
(A) Laminar flow (B) Turbulent flow
(C) Couette flow (D) None of the above

98. The sudden rise in pressure of fluid in a pipe line is known as—
(A) Nammer blow (B) Separation
(C) Surge (D) Hydraulic jump

99. The percentage of slip in reciprocating pumps maintained in good condition is in the order of –
(A) 2 (B) 10
(C) 5 (D) 7

100. The principal advantage of numerical control machine is –
(A) Reduction in set up time
(B) Reduction in machining time
(C) Reduction in number of jigs and fixtures
(D) All of the above

101. The cutting edge of a cold chisel is about—
(A) 30° (B) 45°
(C) 60° (D) 75°

102. The cutting edge of hot chisel is about—
(A) 30° (B) 45°
(C) 60° (D) 75°

103. Cast iron and steel pipes are produced by—
(A) Slush casting
(B) Investement casting
(C) True centrifugal casting
(D) Die casting

104. The casting method adopted for ornaments and toys of non-ferrous alloys, is—
(A) Permanent mould casting
(B) Slush casting
(C) Die casting
(D) Centrifugal casting

105 A casting defect which results in general enlargement of a casting is known as—
(A) Shift (B) Sand wash
(C) Swell (D) Blow whole

106 Green sand is a mixture of—
(A) 30% sand and 70% clay
(B) 50% sand and 50% clay
(C) 70% sand and 30% clay
(D) 90% sand and 10% clay

107. Cores are used to—
(A) Form internal cavities in the casting
(B) Improve mould surface
(C) Form a part of green sand mould
(D) All of the above

108. Swab is used for—
(A) Smoothing and cleaning out depression in the mould
(B) Cleaning the moulding sand
(C) Moistening the sand around the edge before removing pattern
(D) Repairing and finishing the mould

109 The surface to be machined is marked on the pattern by—
(A) Red colour (B) Yellow colour
(C) Black colour (D) Blue colour

110. The surface to be left unmachined is marked on the pattern by—
(A) Red colour (B) Yellow colour
(C) Black colour (D) Blue colour

## Answers

| | | | | |
|---|---|---|---|---|
| 1 (B) | 2. (A) | 3. (B) | 4. (C) | 5. (C) |
| 6. (D) | 7. (A) | 8. (C) | 9. (C) | 10 (C) |
| 11. (B) | 12. (A) | 13. (D) | 14. (A) | 15. (C) |
| 16. (A) | 17. (D) | 18 (C) | 19. (A) | 20. (D) |
| 21 (C) | 22 (B) | 23. (A) | 24. (A) | 25. (C) |
| 26. (A) | 27. (C) | 28 (B) | 29. (A) | 30. (A) |
| 31 (B) | 32. (B) | 33. (B) | 34. (D) | 35. (B) |
| 36. (A) | 37 (B) | 38 (A) | 39. (C) | 40. (A) |
| 41 (C) | 42 (B) | 43 (D) | 44. (A) | 45. (A) |
| 46 (C) | 47 (D) | 48 (C) | 49. (A) | 50 (B) |
| 51 (A) | 52 (D) | 53 (B) | 54. (A) | 55. (D) |
| 56. (A) | 57 (A) | 58 (B) | 59. (A) | 60. (D) |
| 61 (A) | 62 (C) | 63 (D) | 64. (A) | 65. (A) |
| 66. (A) | 67 (C) | 68 (B) | 69 (C) | 70. (C) |
| 71 (B) | 72 (D) | 73 (C) | 74. (A) | 75 (C) |
| 76 (B) | 77 (A) | 78 (C) | 79. (A) | 80. (C) |
| 81 (C) | 82 (C) | 83 (D) | 84 (B) | 85. (D) |
| 86. (D) | 87 (B) | 88 (A) | 89. (A) | 90. (A) |
| 91 (B) | 92 (C) | 93 (C) | 94 (B) | 95. (C) |
| 96. (D) | 97 (C) | 98 (B) | 99. (A) | 100. (D) |
| 101 (C) | 102 (A) | 103 (C) | 104 (B) | 105 (C) |
| 106 (C) | 107 (D) | 108 (C) | 109. (A) | 110 (C) |

# Model Set - 5

1. The selection of site for thermal power plant depends upon the—
   (A) Availability of large quantity of water
   (B) Climatic and atmospheric conditions of the area
   (C) Availability of social and recreational facilities
   (D) None of the above
2. The size of site should be at least—
   (A) Twice the actual size of plant
   (B) Four times the actual size of plant
   (C) Five times the actual size of plant
   (D) Eight times the actual size of plant
3. The main object of plant layout is—
   (A) To make economical use of floor area
   (B) To maintain flexibility of arrangement of operations
   (C) To minimise the material bending
   (D) To produce better quality of product
   (E) All of the above
4. Product layout is used—
   (A) Where expensive machinery is involved
   (B) Where operations require hand tools
   (C) Where product is manufactured in large quantity
   (D) None of the above
5. Process layout is used—
   (A) Where expensive machinery is involved and variety of products are made
   (B) Where operations require hand tools
   (C) Where products are manufactured in large quantity
   (D) All of the above
6. Margin of safety is found by deducing from sales—
   (A) Fixed cost
   (B) Variable cost
   (C) Total cost
   (D) Sales at break even point
7. The factor on which the selection of plant location depends upon—
   (A) Future expansion of plant
   (B) Decentralization of industry
   (C) The cost at which the goods is delivered to the customer
   (D) All of the above
8. The iron and steel industries should be located close to—
   (A) Availability of raw material
   (B) Market
   (C) Availability of large quantity of water
   (D) The big city
9. Which of the layout is used for ship building industry ?
   (A) Fixed position layout
   (B) Process layout
   (C) Product layout
   (D) Combination of process and product layout
10. Economic ordering quantity is the quantity—
   (A) Most uneconomical to order
   (B) Most economical to stock
   (C) Most economical to order
   (D) That enable availing maximum discount
11. Lead times is the average time elapsed between—
   (A) Initiation of the order and receipt of material
   (B) Preparation of purchase order and acceptance or order by supplier
   (C) Placing of order and consumption of present stock
   (D) Consumption of material from minimum level to safety level

12. Fixed position layout is also called as –
    (A) Static product layout
    (B) Process layout
    (C) Analytical layout
    (D) Scientific layout

13. The location of textile industries in and around Mumbai in influenced by the—
    (A) Atmospheric conditions prevailing there and the proximity to market
    (B) Availability of raw material
    (C) Availability of power and fuel
    (D) Availability of skilled workers

14. Good material handling involves—
    (A) Avoiding re-loading
    (B) Eliminating materials handling by hard labour or machine operator
    (C) Using equipment to match the pace of machine operator
    (D) All of the above

15. Which of the following is overhead conveyor ?
    (A) Chain conveyor (B) Power roller
    (C) Belt conveyor (D) Mouorail

16. The type of material handling equipment used for moving high volume of material from one fixed point to another is—
    (A) Cranes (B) Trucks
    (C) Conveyors (D) Hoists

17. Powders, liquids and gases should be transported by—
    (A) Trucks (B) Pipes
    (C) Conveyors (D) None of the above

18. Break-even point is that volume of sales where there is—
    (A) Maximum profit
    (B) Minimum loss
    (C) No profit no loss
    (D) Maximum contribution

19. In product layout—
    (A) A single machine break down may shut down the whole production line
    (B) Machine break down do not help up the production
    (C) More floor space is required
    (D) It is difficult to train workers

20. The chart which indicates the flow of material between various work stations is known as –
    (A) Operational process chart
    (B) Flow process chart
    (C) Travel chart
    (D) All of the above

21 Higher production—
    (A) Means higher productivity
    (B) Means proportional higher productivity
    (C) Always involves higher productivity
    (D) Does not necessarily mean higher productivity

22. Improving the production means—
    (A) Increased production with same input
    (B) Increased production with lesser input
    (C) Lower wastages per unit of output
    (D) All of the above

23 Which one of the follwing methods of increasing production is not through as improvement in productivity ?
    (A) Increasing plant and equipment capacity
    (B) Better utilisation of plant and equipment
    (C) Simplification of basic design
    (D) Increasing the motivation of workers

24. Reduction in cost per unit may be the result of—
    (A) Reduced expenditure, volume of production remaining same
    (B) Higher production at same level of expenditure
    (C) Higher production as a result of higher productivity
    (D) All of the above

25 Cost reduction—
    (A) Means reduction in total fixed cost of a business
    (B) Means reduction in material cost per unit
    (C) Means reduction in per unit cost of goods produced
    (D) All of the above

26. Higher productivity can be achieved—
    (A) By negotiating with trade unions
    (B) By not insisting on strict quality control

(C) Proper system of preventive maintenance of machinery

(D) All of the above

27. Work simplification aims to—

(A) Determine how much time a job should take for completion

(B) Determine how a job should be done to increase productivity

(C) Find out how much time is lost in unproductive activity

(D) None of the above

28. Critical path is as certained in—

(A) CPM method

(B) PERT method

(C) Both of the above

(D) None of the above

29 Break even analysis—

(A) Facilitates segregation of semi variable costs into fixed and variable cost

(B) Requires segregation of semi-variable costs into fixed and variable cost

(C) Assumes all costs as variable

(D) Assumes all costs as semi-variable

30 Angle of incidence is angle formed by sales line and—

(A) Total cost line at break even point

(B) Variable cost line at break even point

(C) Fixed cost line

(D) Contribution line

31 Break even analysis is used for—

(A) Forecasting costs and profit as a result of change in volume

(B) Fixation of sales volume to earn a given profit

(C) Determination of sales price which would give a desired profit

(D) All of the above

32. The formula used to find target quantity to have desired profit is—

(A) Fixed cost – Target profit

(B) Fixed cost + Target profit

(C) $\frac{\text{Fixed cost + Target profit}}{\text{Contribution per unit}}$

(D) $\frac{\text{Fixed cost + Variable cost}}{\text{Target profit}}$

33. The symbol representing storage in a process chart is –

(A) O□ (B) Δ□

(C) ⌒ (D)

34 PERT stands for—

(A) Period estimation and revision technique

(B) Project estimation and revision technique

(C) Project evalution and revision technique

(D) Programme evalution and review technique

35. In network diagram an arrow represents—

(A) The direction (B) An activity

(C) An event (D) All of the above

36. In network diagram a circle represents—

(A) An event

(B) Completion of the project

(C) Inactivity

(D) Shifting of resources from one activity to another activity

37 Time estimates on each activity under PERT are made on the basis of—

(A) Optimistic estimate

(B) Normal estimate

(C) Pessimistic estimate

(D) All of the above

38. Dummy activity—

(A) Consumes no resources

(B) Consumes resources but does not take time

(C) Takes time but does not consumes resources

(D) Requires both time and resources

39 Time variance of various activities in a net work is given by—

(A) Pessimistic time—Optimistic time

(B) (Pessimistic time—optimistic time)$^2$

(C) $\frac{\text{(Pessimistic time—optimistic time)}^2}{2}$

(D) $\frac{\text{(Pessimistic time optimistic time)}^2}{6}$

40. Binary Coded Decimal (B.C.D.) equivalent of 5 is –
    (A) 0100 (B) 0101
    (C) 0010 (D) 0110

41. Time study is—
    (A) Determination standard time for an operation
    (B) Eliminating unnecessary work
    (C) Carried out before work study
    (D) Carried out for most efficient worker

42. Operating system is a part of—
    (A) Hardware
    (B) Software
    (C) Both hardware and software
    (D) None of the above

43. Software means—
    (A) Programming techniques developed efficient use of computer hardware
    (B) Mechanical, electrical, magnetic and electronic components of computer system
    (C) Conversion process of high level language programme into machine language
    (D) None of the above

44. A standard punched card has—
    (A) 80 columns and 8 rows
    (B) 80 columns and 10 rows
    (C) 80 columns and 12 rows
    (D) 100 columns and 10 rows

45. For measuring standard time—
    (A) An operator who is trained and experienced is selected
    (B) An unskilled operator is selected
    (C) A semi- skilled operator is selected
    (D) An unexperienced operator is selected

46. The chart showing relationship between man time and machine time is known as—
    (A) Multiple activity chart
    (B) Flow process chart
    (C) Process chart
    (D) None of these

47. In time study, the measurement of actual observed time is done by—
    (A) A stop watch
    (B) A motion picture camera
    (C) The machines using moving tape and disc
    (D) Any of the above

48. Basic time is expressed by the relation—
    (A) $\frac{\text{Observed time} \times \text{Standard rating}}{\text{Observed rating}}$
    (B) $\frac{\text{Observed time} \times \text{Observed rating}}{\text{Standard rating}}$
    (C) $\frac{\text{Standard rating} \times \text{Observed rating}}{\text{Observed time}}$
    (D) $\frac{\text{Observed time}}{\text{Standard rating}}$

49. The chart used for analysing linear relationship between operations is known as—
    (A) Gantt chart
    (B) Travel chart
    (C) Statistical quality control chart
    (D) Emerson chart

50. Routing and scheduling are integral parts of—
    (A) Work study
    (B) Production planning
    (C) Statistical quality control
    (D) Job analysis

51. The inspection of each and every product is known as—
    (A) Sampling inspection
    (B) Hundred per cent inspection
    (C) Functional inspection
    (D) First off inspection

52. Group bonus system is used for—
    (A) Direct workers for payment by results because their efficiency is not difficult to measure
    (B) Indirect workers because their efficiency is difficult to measure
    (C) Support individual bonus system
    (D) Fixing maximum percentage of bonus to be used under different individual bonus system

53. Under Halsey premium plan a worker who takes the same time as allowed time receives remuneration —
(A) At piece rate
(B) At piece rate with 10% efficiency bonus
(C) At time rate
(D) At time rate with 10% efficiency bonus

54. Magnetic disc provides for ability to record and relative stored data—
(A) Sequentially only
(B) Randomly only
(C) Sequentially or randomly
(D) Systematically

55. If carbon is represented as ${}_6C^{12}$, then the number of electrons are equal to—
(A) 6 (B) 12
(C) 18 (D) 2

56. The cooling system used in air craft is—
(A) Vapour compression system
(B) Vapour absorption system
(C) Air cycle refrigeration system
(D) Steam jet water vapour system

57. The leakage of air into the refrigeration system will—
(A) Lower its cooling efficiency
(B) Increase cooling efficiency
(C) Not affect its cooling efficiency
(D) Increase the C.O.P

58. The sensible heat factor is equal to—
(A) $\frac{\text{Sensible heat}}{\text{Latent heat}}$
(B) $\frac{\text{Latent heat}}{\text{Sensible heat}}$
(C) $\frac{\text{Sensible heat}}{\text{Sensible heat + Latent heat}}$
(D) $\frac{\text{Sensible heat + Latent heat}}{\text{Latent heat}}$

59. The amount of outdoor air required per person in an air conditioning for general purpose is—
(A) 0·4 cu. metre (B) 0·25 cu. metre
(C) 0·8 cu. metre (D) 1·2 cu. metre

60. The dehumidification of air will change its—
(A) Dry bulb temperature
(B) Wet bulb temperature
(C) Humidity ratio
(D) All of the above
(E) None of the above

61. The angle formation in cooling towers is controlled by—
(A) Using water of pH value equal to 5
(B) Blowing down water at intervals
(C) Adding chemicals, such as chlorinated lime, potassium permanganate, liquid chlorine, in water
(D) None of the above

62. The corrosion in cooling towers and condensers can be controlled by keeping the pH value of water between—
(A) 0-2 (B) 2-4
(C) 6·5 to 7·5 (D) 10 to 14

63. The performance of reciprocating compressors compared by their—
(A) Isothermal efficiency
(B) Adiabatic efficiency
(C) Mechanical efficiency
(D) Overall efficiency

64. The thermal efficiency of an open cycle gas turbine increases with the—
(A) Increase in inlet temperature of atmospheric air
(B) Decrease in inlet temperature of atmospheric air
(C) Remain same for all temperatures of inlet air
(D) None of the above

65. The performance of centrifugal compressors is compared by their—
(A) Mechanical efficiency
(B) Overall efficiency
(C) Adiabatic efficiency
(D) Isothermal efficiency

66. A perfect gas is one which obey's—
(A) All gas law's
(B) Only Boyle's law
(C) Only Charle's law
(D) None of the above

67. In metric system the unit of heat is given as—
(A) C.H.U. (B) B T U.
(C) K.cal (D) Kelvin

68. In an adiabatic process—
(A) The temperature remains constant
(B) The pressure and volume remains constant
(C) Work done is zero
(D) There is no flow of heat into and out of the system.

69. The main function of shielding a reactor is to—
(A) Prevent heat loss from the nuclear plant
(B) Reduce the amount of radiation reaching one region of space to another region of space
(C) Prevent damage to the plant
(D) Protect it from heat and light

70 In a heterogeneous reactor metallic uranium rods are clad with—
(A) Aluminium (B) Zirconium
(C) Stainless steel (D) All of the above

71 The main function of shielding in a nuclear reactor is to provide protection against—
(A) α-rays (B) β-rays
(C) Gamma-rays (D) Electrons

72 The scram control rods are used to-
(A) Control the chain reaction in the reactor
(B) Prevent radiation from the reaction
(C) Control the pressure of steam
(D) None of the above

73 The coolant used in the Nuclear Plant should have—
(A) Low coefficient of heat
(B) The tendency to absorb neutrons as low as possible
(C) High induced radio activity
(D) None of the above

74. The material used to slow down neutrons released during the fission process is known as—
(A) Moderator
(B) Fertile material
(C) Fissionable fuel
(D) Reflector

75. The device used to regulate the flow of the refrigerant in a system is known as—
(A) Capillary tube
(B) Solenoid valve
(C) Thermostatic expansion valve
(D) None of the above
(E) All of the above

76. The dry bulb temperature lines of psychrometric chart are—
(A) Vertical (B) Horizontal
(C) Inclined (D) Curved

77 Potential energy possessed by a body is given by the relation—
(A) $mgh$ (B) $mh$
(C) $\frac{m}{o}h$ (D) $\frac{1}{2}mv^2$

78. The temperature of the air leaving the cooling coil as compared to the apparatus dew point temperature is—
(A) More (B) Less
(C) Same (D) Unpredictable

79. In evaporative type of condenser, the refrigerant is cooled by—
(A) The water
(B) The air
(C) Both air and water
(D) None of the above

80. The By Pass Factor (BPF) is expressed as—
(A) $\frac{dt_1 - t_{coil}}{dt_2 - t_{coil}}$ (B) $\frac{dt_1 + t_{coil}}{dt_2 - t_{coil}}$
(C) $\frac{dt_1 - t_{coil}}{dt_2 + t_{coil}}$ (D) $\frac{dt_1 + t_{coil}}{dt_2 + t_{coil}}$

81 According to Newton's law of cooling, the rate of heat transfer from a solid surface of area A, at a temperature $t_1$, to fluid at temperature $t_2$, is given by—
(A) $Q = hA(t_1 - t_2)$ (B) $Q = hA(t_1 + t_2)$
(C) $Q = \frac{h}{A}(t_1 - t_2)$ (D) $Q = \frac{A}{h}(t_1 - t_2)$

82. In a vapour compression system, the compression of refrigerant vapour follows the law—
(A) $(pv^r = C)$ (B) $(pv = C)$
(C) $(pv^n = C)$ (D) None of the above

83. In case of dry compression the vapours—
(A) Enter the compressor in wet state
(B) Leave the compressor in dry saturated state
(C) Enter the compressor in dry saturated state
(D) None of the above

84. The coefficient of performance of a machine in case of wet compression as compared to dry compression is—
(A) More (B) Less
(C) Same (D) Unpredictable

85. The coefficient of performance of a refrigerating machine is given by the relation—
(A) $C.O.P. = \frac{W}{N}$
(B) $C.O.P. = \frac{N}{W}$
(C) $C.O.P. = N \times W$
(D) $C.O.P. = W - N$

86. The capacity of a refrigerating machine is expressed in—
(A) Tonns of refrigeration
(B) Term of lowest temperature attained
(C) Term of weight of a machine
(D) Term of volume of a space to be cooled

87. Which one of the following is most harmful for the human body ?
(A) Alpha particles
(B) Beta particles
(C) Gamma particles
(D) None of the above

88. Pick up the correct equation in which alpha particle is emitted—
(A) $_{92}U^{238} \rightarrow {}_{2}He^{4} + {}_{90}Th^{234}$
(B) $_{92}U^{238} \rightarrow {}_{2}He^{4} + {}_{92}Th^{238}$
(C) $_{92}U^{238} \rightarrow {}_{4}He^{2} + {}_{90}Th^{234}$
(D) $_{92}U^{238} \rightarrow {}_{2}He^{4} + {}_{94}Th^{242}$

89. The readily fissionable material is—
(A) Uranium-234 (B) Uranium-235
(C) Uranium-238 (D) All of the above

90. One kg. of uranium will produce energy equivalent to approximate—
(A) 30,000 tonnes of coal
(B) 30 tonnes of coal
(C) 3000 tonnes of coal
(D) 300 tonnes of coal

91 Combining of light nuclides to form a single heavy nucleus is called—
(A) Fusion (B) Fission
(C) Solidification (D) Atomization

92. The division of heavy nucleus into smaller ones is called—
(A) Fusion
(B) Fission
(C) Vaporization
(D) None of the above

93 Fertile material is that which—
(A) Can be transformed into a fissionable material by capture of neutron
(B) Cannot be transformed into a fissionable material
(C) Is used as basic raw material for nuclear power plant
(D) None of the above

94. Isotopes of the element has—
(A) Same number of neutrons
(B) Different number of neutrons
(C) Same atomic weight
(D) None of the above

95. If Berylium is represented as $_{5}Be^{9}$, then the number of neutrons are equal to—
(A) 9 (B) 5
(C) 14 (D) 4

96 The room air conditioner controls the—
(A) Temperature of the air
(B) Temperature and humidity of the air
(C) Temperature and dust of the air
(D) None of these

97. The milk is stored at a temperature of—
(A) 4°C (B) – 5°C
(C) 10°C (D) 12°C

98. The process of heating and immediately cooling the milk for controlling the bacterial growth is known as—
(A) Pasteurisation (B) Regeneration
(C) Blending (D) None of these

99 The value of Poisson's ratio for steel varies from –

(A) 0·20 to 0·25 (B) 0·25 to 0·35

(C) 0·35 to 0·40 (D) 0·40 to 0·55

100. A composite section, contains four different materials. The stresses in all the different materials will be—

(A) Zero

(B) Equal

(C) Different

(D) In the ratio of their areas

101. The maximum stress produced in a bar of tapering section is at—

(A) Larger end (B) Smaller end

(C) Middle (D) None of these

102. Which of the following is a non-destructive test ?

(A) Tensile test

(B) Ultrasonic test

(C) Compression test

(D) Creep test

103 Cementite consists of—

(A) 13 per cent carbon and 87 per cent ferrite

(B) 13 per cent cementite and 87 per cent ferrite

(C) 13 per cent ferrite and 87 per cent cementite

(D) 6·67 per cent carbon and 93·33 per cent iron

104. The essential constituent of a hardness steel is—

(A) Pearlite (B) Austenite

(C) Martensite (D) Troostite

105. An eutectoid steel consists of –

(A) Wholly pearlite

(B) Wholly austenite

(C) Pearlite and ferrite

(D) Pearlite and cementite

## Answers

| | | | | |
|---|---|---|---|---|
| 1. (A) | 2. (C) | 3. (E) | 4 (C) | 5 (A) |
| 6. (D) | 7. (D) | 8. (A) | 9 (A) | 10. (C) |
| 11. (A) | 12. (A) | 13. (A) | 14. (D) | 15. (D) |
| 16. (C) | 17. (B) | 18. (C) | 19. (A) | 20 (C) |
| 21. (D) | 22. (D) | 23. (A) | 24. (D) | 25. (C) |
| 26 (C) | 27. (B) | 28. (C) | 29. (B) | 30. (A) |
| 31. (D) | 32. (C) | 33. (B) | 34. (D) | 35. (B) |
| 36. (A) | 37. (D) | 38. (A) | 39. (D) | 40. (B) |
| 41 (A) | 42. (B) | 43. (A) | 44 (C) | 45. (A) |
| 46. (A) | 47 (B) | 48. (B) | 49. (A) | 50. (B) |
| 51. (B) | 52 (B) | 53. (C) | 54 (C) | 55. (A) |
| 56 (C) | 57. (A) | 58 (C) | 59. (B) | 60. (D) |
| 61 (C) | 62 (C) | 63. (A) | 64 (B) | 65. (C) |
| 66. (A) | 67 (C) | 68 (D) | 69. (B) | 70. (D) |
| 71 (C) | 72 (A) | 73 (B) | 74. (A) | 75. (E) |
| 76. (A) | 77 (A) | 78 (A) | 79 (C) | 80. (A) |
| 81 (A) | 82 (A) | 83 (C) | 84. (A) | 85. (A) |
| 86. (A) | 87 (C) | 88 (A) | 89 (B) | 90 (C) |
| 91 (A) | 92 (B) | 93 (A) | 94 (B) | 95. (D) |
| 96 (B) | 97 (A) | 98 (A) | 99 (B) | 100 (C) |
| 101 (B) | 102 (B) | 103 (D) | 104 (C) | 105. (A) |

# Model Set - 5

1. The selection of site for thermal power plant depends upon the—
   (A) Availability of large quantity of water
   (B) Climatic and atmospheric conditions of the area
   (C) Availability of social and recreational facilities
   (D) None of the above
2. The size of site should be at least—
   (A) Twice the actual size of plant
   (B) Four times the actual size of plant
   (C) Five times the actual size of plant
   (D) Eight times the actual size of plant
3. The main object of plant layout is—
   (A) To make economical use of floor area
   (B) To maintain flexibility of arrangement of operations
   (C) To minimise the material bending
   (D) To produce better quality of product
   (E) All of the above
4. Product layout is used—
   (A) Where expensive machinery is involved
   (B) Where operations require hand tools
   (C) Where product is manufactured in large quantity
   (D) None of the above
5. Process layout is used—
   (A) Where expensive machinery is involved and variety of products are made
   (B) Where operations require hand tools
   (C) Where products are manufactured in large quantity
   (D) All of the above
6. Margin of safety is found by deducing from sales—
   (A) Fixed cost
   (B) Variable cost
   (C) Total cost
   (D) Sales at break even point
7. The factor on which the selection of plant location depends upon—
   (A) Future expansion of plant
   (B) Decentralization of industry
   (C) The cost at which the goods is delivered to the customer
   (D) All of the above
8. The iron and steel industries should be located close to—
   (A) Availability of raw material
   (B) Market
   (C) Availability of large quantity of water
   (D) The big city
9. Which of the layout is used for ship building industry ?
   (A) Fixed position layout
   (B) Process layout
   (C) Product layout
   (D) Combination of process and product layout
10. Economic ordering quantity is the quantity—
   (A) Most uneconomical to order
   (B) Most economical to stock
   (C) Most economical to order
   (D) That enable availing maximum discount
11. Lead times is the average time elapsed between—
   (A) Initiation of the order and receipt of material
   (B) Preparation of purchase order and acceptance or order by supplier
   (C) Placing of order and consumption of present stock
   (D) Consumption of material from minimum level to safety level

12. Fixed position layout is also called as –
    (A) Static product layout
    (B) Process layout
    (C) Analytical layout
    (D) Scientific layout

13. The location of textile industries in and around Mumbai in influenced by the—
    (A) Atmospheric conditions prevailing there and the proximity to market
    (B) Availability of raw material
    (C) Availability of power and fuel
    (D) Availability of skilled workers

14. Good material handling involves—
    (A) Avoiding re-loading
    (B) Eliminating materials handling by hard labour or machine operator
    (C) Using equipment to match the pace of machine operator
    (D) All of the above

15. Which of the following is overhead conveyor ?
    (A) Chain conveyor (B) Power roller
    (C) Belt conveyor (D) Mouorail

16. The type of material handling equipment used for moving high volume of material from one fixed point to another is—
    (A) Cranes (B) Trucks
    (C) Conveyors (D) Hoists

17. Powders, liquids and gases should be transported by—
    (A) Trucks (B) Pipes
    (C) Conveyors (D) None of the above

18. Break-even point is that volume of sales where there is—
    (A) Maximum profit
    (B) Minimum loss
    (C) No profit no loss
    (D) Maximum contribution

19. In product layout—
    (A) A single machine break down may shut down the whole production line
    (B) Machine break down do not help up the production
    (C) More floor space is required
    (D) It is difficult to train workers

20. The chart which indicates the flow of material between various work stations is known as –
    (A) Operational process chart
    (B) Flow process chart
    (C) Travel chart
    (D) All of the above

21 Higher production—
    (A) Means higher productivity
    (B) Means proportional higher productivity
    (C) Always involves higher productivity
    (D) Does not necessarily mean higher productivity

22. Improving the production means—
    (A) Increased production with same input
    (B) Increased production with lesser input
    (C) Lower wastages per unit of output
    (D) All of the above

23 Which one of the follwing methods of increasing production is not through as improvement in productivity ?
    (A) Increasing plant and equipment capacity
    (B) Better utilisation of plant and equipment
    (C) Simplification of basic design
    (D) Increasing the motivation of workers

24. Reduction in cost per unit may be the result of—
    (A) Reduced expenditure, volume of production remaining same
    (B) Higher production at same level of expenditure
    (C) Higher production as a result of higher productivity
    (D) All of the above

25 Cost reduction—
    (A) Means reduction in total fixed cost of a business
    (B) Means reduction in material cost per unit
    (C) Means reduction in per unit cost of goods produced
    (D) All of the above

26. Higher productivity can be achieved—
    (A) By negotiating with trade unions
    (B) By not insisting on strict quality control

(C) Proper system of preventive maintenance of machinery

(D) All of the above

27. Work simplification aims to—

(A) Determine how much time a job should take for completion

(B) Determine how a job should be done to increase productivity

(C) Find out how much time is lost in unproductive activity

(D) None of the above

28. Critical path is as certained in—

(A) CPM method

(B) PERT method

(C) Both of the above

(D) None of the above

29 Break even analysis—

(A) Facilitates segregation of semi variable costs into fixed and variable cost

(B) Requires segregation of semi-variable costs into fixed and variable cost

(C) Assumes all costs as variable

(D) Assumes all costs as semi-variable

30 Angle of incidence is angle formed by sales line and—

(A) Total cost line at break even point

(B) Variable cost line at break even point

(C) Fixed cost line

(D) Contribution line

31 Break even analysis is used for—

(A) Forecasting costs and profit as a result of change in volume

(B) Fixation of sales volume to earn a given profit

(C) Determination of sales price which would give a desired profit

(D) All of the above

32. The formula used to find target quantity to have desired profit is—

(A) Fixed cost – Target profit

(B) Fixed cost + Target profit

(C) $\frac{\text{Fixed cost + Target profit}}{\text{Contribution per unit}}$

(D) $\frac{\text{Fixed cost + Variable cost}}{\text{Target profit}}$

33. The symbol representing storage in a process chart is –

(A) O□ (B) Δ□

(C) ⌒ (D)

34 PERT stands for—

(A) Period estimation and revision technique

(B) Project estimation and revision technique

(C) Project evalution and revision technique

(D) Programme evalution and review technique

35. In network diagram an arrow represents—

(A) The direction (B) An activity

(C) An event (D) All of the above

36. In network diagram a circle represents—

(A) An event

(B) Completion of the project

(C) Inactivity

(D) Shifting of resources from one activity to another activity

37 Time estimates on each activity under PERT are made on the basis of—

(A) Optimistic estimate

(B) Normal estimate

(C) Pessimistic estimate

(D) All of the above

38. Dummy activity—

(A) Consumes no resources

(B) Consumes resources but does not take time

(C) Takes time but does not consumes resources

(D) Requires both time and resources

39 Time variance of various activities in a net work is given by—

(A) Pessimistic time—Optimistic time

(B) (Pessimistic time—optimistic time)$^2$

(C) $\frac{\text{(Pessimistic time—optimistic time)}^2}{2}$

(D) $\frac{\text{(Pessimistic time optimistic time)}^2}{6}$

40. Binary Coded Decimal (B.C.D.) equivalent of 5 is –
    (A) 0100 (B) 0101
    (C) 0010 (D) 0110

41. Time study is—
    (A) Determination standard time for an operation
    (B) Eliminating unnecessary work
    (C) Carried out before work study
    (D) Carried out for most efficient worker

42. Operating system is a part of—
    (A) Hardware
    (B) Software
    (C) Both hardware and software
    (D) None of the above

43. Software means—
    (A) Programming techniques developed efficient use of computer hardware
    (B) Mechanical, electrical, magnetic and electronic components of computer system
    (C) Conversion process of high level language programme into machine language
    (D) None of the above

44. A standard punched card has—
    (A) 80 columns and 8 rows
    (B) 80 columns and 10 rows
    (C) 80 columns and 12 rows
    (D) 100 columns and 10 rows

45. For measuring standard time—
    (A) An operator who is trained and experienced is selected
    (B) An unskilled operator is selected
    (C) A semi- skilled operator is selected
    (D) An unexperienced operator is selected

46. The chart showing relationship between man time and machine time is known as—
    (A) Multiple activity chart
    (B) Flow process chart
    (C) Process chart
    (D) None of these

47. In time study, the measurement of actual observed time is done by—
    (A) A stop watch
    (B) A motion picture camera
    (C) The machines using moving tape and disc
    (D) Any of the above

48. Basic time is expressed by the relation—
    (A) $\frac{\text{Observed time} \times \text{Standard rating}}{\text{Observed rating}}$
    (B) $\frac{\text{Observed time} \times \text{Observed rating}}{\text{Standard rating}}$
    (C) $\frac{\text{Standard rating} \times \text{Observed rating}}{\text{Observed time}}$
    (D) $\frac{\text{Observed time}}{\text{Standard rating}}$

49. The chart used for analysing linear relationship between operations is known as—
    (A) Gantt chart
    (B) Travel chart
    (C) Statistical quality control chart
    (D) Emerson chart

50. Routing and scheduling are integral parts of—
    (A) Work study
    (B) Production planning
    (C) Statistical quality control
    (D) Job analysis

51. The inspection of each and every product is known as—
    (A) Sampling inspection
    (B) Hundred per cent inspection
    (C) Functional inspection
    (D) First off inspection

52. Group bonus system is used for—
    (A) Direct workers for payment by results because their efficiency is not difficult to measure
    (B) Indirect workers because their efficiency is difficult to measure
    (C) Support individual bonus system
    (D) Fixing maximum percentage of bonus to be used under different individual bonus system

53. Under Halsey premium plan a worker who takes the same time as allowed time receives remuneration —
(A) At piece rate
(B) At piece rate with 10% efficiency bonus
(C) At time rate
(D) At time rate with 10% efficiency bonus

54. Magnetic disc provides for ability to record and relative stored data—
(A) Sequentially only
(B) Randomly only
(C) Sequentially or randomly
(D) Systematically

55. If carbon is represented as ${}_6C^{12}$, then the number of electrons are equal to—
(A) 6 (B) 12
(C) 18 (D) 2

56. The cooling system used in air craft is—
(A) Vapour compression system
(B) Vapour absorption system
(C) Air cycle refrigeration system
(D) Steam jet water vapour system

57. The leakage of air into the refrigeration system will—
(A) Lower its cooling efficiency
(B) Increase cooling efficiency
(C) Not affect its cooling efficiency
(D) Increase the C.O.P

58. The sensible heat factor is equal to—
(A) $\frac{\text{Sensible heat}}{\text{Latent heat}}$
(B) $\frac{\text{Latent heat}}{\text{Sensible heat}}$
(C) $\frac{\text{Sensible heat}}{\text{Sensible heat + Latent heat}}$
(D) $\frac{\text{Sensible heat + Latent heat}}{\text{Latent heat}}$

59. The amount of outdoor air required per person in an air conditioning for general purpose is—
(A) 0·4 cu. metre (B) 0·25 cu. metre
(C) 0·8 cu. metre (D) 1·2 cu. metre

60. The dehumidification of air will change its—
(A) Dry bulb temperature
(B) Wet bulb temperature
(C) Humidity ratio
(D) All of the above
(E) None of the above

61. The angle formation in cooling towers is controlled by—
(A) Using water of pH value equal to 5
(B) Blowing down water at intervals
(C) Adding chemicals, such as chlorinated lime, potassium permanganate, liquid chlorine, in water
(D) None of the above

62. The corrosion in cooling towers and condensers can be controlled by keeping the pH value of water between—
(A) 0-2 (B) 2-4
(C) 6·5 to 7·5 (D) 10 to 14

63. The performance of reciprocating compressors compared by their—
(A) Isothermal efficiency
(B) Adiabatic efficiency
(C) Mechanical efficiency
(D) Overall efficiency

64. The thermal efficiency of an open cycle gas turbine increases with the—
(A) Increase in inlet temperature of atmospheric air
(B) Decrease in inlet temperature of atmospheric air
(C) Remain same for all temperatures of inlet air
(D) None of the above

65. The performance of centrifugal compressors is compared by their—
(A) Mechanical efficiency
(B) Overall efficiency
(C) Adiabatic efficiency
(D) Isothermal efficiency

66. A perfect gas is one which obey's—
(A) All gas law's
(B) Only Boyle's law
(C) Only Charle's law
(D) None of the above

67. In metric system the unit of heat is given as—
(A) C.H.U. (B) B.T.U.
(C) K.cal (D) Kelvin

68. In an adiabatic process—
(A) The temperature remains constant
(B) The pressure and volume remains constant
(C) Work done is zero
(D) There is no flow of heat into and out of the system.

69. The main function of shielding a reactor is to—
(A) Prevent heat loss from the nuclear plant
(B) Reduce the amount of radiation reaching one region of space to another region of space
(C) Prevent damage to the plant
(D) Protect it from heat and light

70. In a heterogeneous reactor metallic uranium rods are clad with—
(A) Aluminium (B) Zirconium
(C) Stainless steel (D) All of the above

71. The main function of shielding in a nuclear reactor is to provide protection against—
(A) α-rays (B) β-rays
(C) Gamma-rays (D) Electrons

72. The scram control rods are used to-
(A) Control the chain reaction in the reactor
(B) Prevent radiation from the reaction
(C) Control the pressure of steam
(D) None of the above

73. The coolant used in the Nuclear Plant should have—
(A) Low coefficient of heat
(B) The tendency to absorb neutrons as low as possible
(C) High induced radio activity
(D) None of the above

74. The material used to slow down neutrons released during the fission process is known as—
(A) Moderator
(B) Fertile material
(C) Fissionable fuel
(D) Reflector

75. The device used to regulate the flow of the refrigerant in a system is known as—
(A) Capillary tube
(B) Solenoid valve
(C) Thermostatic expansion valve
(D) None of the above
(E) All of the above

76. The dry bulb temperature lines of psychrometric chart are—
(A) Vertical (B) Horizontal
(C) Inclined (D) Curved

77. Potential energy possessed by a body is given by the relation—
(A) $mgh$ (B) $mh$
(C) $\frac{m}{o}h$ (D) $\frac{1}{2}mv^2$

78. The temperature of the air leaving the cooling coil as compared to the apparatus dew point temperature is—
(A) More (B) Less
(C) Same (D) Unpredictable

79. In evaporative type of condenser, the refrigerant is cooled by—
(A) The water
(B) The air
(C) Both air and water
(D) None of the above

80. The By Pass Factor (BPF) is expressed as—
(A) $\frac{dt_1 - t_{coil}}{dt_2 - t_{coil}}$ (B) $\frac{dt_1 + t_{coil}}{dt_2 - t_{coil}}$
(C) $\frac{dt_1 - t_{coil}}{dt_2 + t_{coil}}$ (D) $\frac{dt_1 + t_{coil}}{dt_2 + t_{coil}}$

81. According to Newton's law of cooling, the rate of heat transfer from a solid surface of area A, at a temperature $t_1$, to fluid at temperature $t_2$, is given by—
(A) $Q = hA(t_1 - t_2)$ (B) $Q = hA(t_1 + t_2)$
(C) $Q = \frac{h}{A}(t_1 - t_2)$ (D) $Q = \frac{A}{h}(t_1 - t_2)$

82. In a vapour compression system, the compression of refrigerant vapour follows the law—
(A) $(pv^r = C)$ (B) $(pv = C)$
(C) $(pv^n = C)$ (D) None of the above

83. In case of dry compression the vapours—
(A) Enter the compressor in wet state
(B) Leave the compressor in dry saturated state
(C) Enter the compressor in dry saturated state
(D) None of the above

84. The coefficient of performance of a machine in case of wet compression as compared to dry compression is—
(A) More (B) Less
(C) Same (D) Unpredictable

85. The coefficient of performance of a refrigerating machine is given by the relation—
(A) $C.O.P. = \frac{W}{N}$
(B) $C.O.P. = \frac{N}{W}$
(C) $C.O.P. = N \times W$
(D) $C.O.P. = W - N$

86. The capacity of a refrigerating machine is expressed in—
(A) Tonns of refrigeration
(B) Term of lowest temperature attained
(C) Term of weight of a machine
(D) Term of volume of a space to be cooled

87. Which one of the following is most harmful for the human body ?
(A) Alpha particles
(B) Beta particles
(C) Gamma particles
(D) None of the above

88. Pick up the correct equation in which alpha particle is emitted—
(A) $_{92}U^{238} \rightarrow {}_{2}He^{4} + {}_{90}Th^{234}$
(B) $_{92}U^{238} \rightarrow {}_{2}He^{4} + {}_{92}Th^{238}$
(C) $_{92}U^{238} \rightarrow {}_{4}He^{2} + {}_{90}Th^{234}$
(D) $_{92}U^{238} \rightarrow {}_{2}He^{4} + {}_{94}Th^{242}$

89. The readily fissionable material is—
(A) Uranium-234 (B) Uranium-235
(C) Uranium-238 (D) All of the above

90. One kg. of uranium will produce energy equivalent to approximate—
(A) 30,000 tonnes of coal
(B) 30 tonnes of coal
(C) 3000 tonnes of coal
(D) 300 tonnes of coal

91. Combining of light nuclides to form a single heavy nucleus is called—
(A) Fusion (B) Fission
(C) Solidification (D) Atomization

92. The division of heavy nucleus into smaller ones is called—
(A) Fusion
(B) Fission
(C) Vaporization
(D) None of the above

93. Fertile material is that which—
(A) Can be transformed into a fissionable material by capture of neutron
(B) Cannot be transformed into a fissionable material
(C) Is used as basic raw material for nuclear power plant
(D) None of the above

94. Isotopes of the element has—
(A) Same number of neutrons
(B) Different number of neutrons
(C) Same atomic weight
(D) None of the above

95. If Beryllium is represented as $_{5}Be^{9}$, then the number of neutrons are equal to—
(A) 9 (B) 5
(C) 14 (D) 4

96. The room air conditioner controls the—
(A) Temperature of the air
(B) Temperature and humidity of the air
(C) Temperature and dust of the air
(D) None of these

97. The milk is stored at a temperature of—
(A) 4°C (B) – 5°C
(C) 10°C (D) 12°C

98. The process of heating and immediately cooling the milk for controlling the bacterial growth is known as—
(A) Pasteurisation (B) Regeneration
(C) Blending (D) None of these

99. The value of Poisson's ratio for steel varies from—
(A) 0·20 to 0·25 (B) 0·25 to 0·35
(C) 0·35 to 0·40 (D) 0·40 to 0·55

100. A composite section, contains four different materials. The stresses in all the different materials will be—
(A) Zero
(B) Equal
(C) Different
(D) In the ratio of their areas

101. The maximum stress produced in a bar of tapering section is at—
(A) Larger end (B) Smaller end
(C) Middle (D) None of these

102. Which of the following is a non-destructive test ?
(A) Tensile test
(B) Ultrasonic test
(C) Compression test
(D) Creep test

103. Cementite consists of—
(A) 13 per cent carbon and 87 per cent ferrite
(B) 13 per cent cementite and 87 per cent ferrite
(C) 13 per cent ferrite and 87 per cent cementite
(D) 6·67 per cent carbon and 93·33 per cent iron

104. The essential constituent of a hardness steel is—
(A) Pearlite (B) Austenite
(C) Martensite (D) Troostite

105. An eutectoid steel consists of—
(A) Wholly pearlite
(B) Wholly austenite
(C) Pearlite and ferrite
(D) Pearlite and cementite

## Answers

| | | | | |
|---|---|---|---|---|
| 1. (A) | 2. (C) | 3. (E) | 4. (C) | 5. (A) |
| 6. (D) | 7. (D) | 8. (A) | 9. (A) | 10. (C) |
| 11. (A) | 12. (A) | 13. (A) | 14. (D) | 15. (D) |
| 16. (C) | 17. (B) | 18. (C) | 19. (A) | 20. (C) |
| 21. (D) | 22. (D) | 23. (A) | 24. (D) | 25. (C) |
| 26. (C) | 27. (B) | 28. (C) | 29. (B) | 30. (A) |
| 31. (D) | 32. (C) | 33. (B) | 34. (D) | 35. (B) |
| 36. (A) | 37. (D) | 38. (A) | 39. (D) | 40. (B) |
| 41. (A) | 42. (B) | 43. (A) | 44. (C) | 45. (A) |
| 46. (A) | 47. (B) | 48. (B) | 49. (A) | 50. (B) |
| 51. (B) | 52. (B) | 53. (C) | 54. (C) | 55. (A) |
| 56. (C) | 57. (A) | 58. (C) | 59. (B) | 60. (D) |
| 61. (C) | 62. (C) | 63. (A) | 64. (B) | 65. (C) |
| 66. (A) | 67. (C) | 68. (D) | 69. (B) | 70. (D) |
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| 86. (A) | 87. (C) | 88. (A) | 89. (B) | 90. (C) |
| 91. (A) | 92. (B) | 93. (A) | 94. (B) | 95. (D) |
| 96. (B) | 97. (A) | 98. (A) | 99. (B) | 100. (C) |
| 101. (B) | 102. (B) | 103. (D) | 104. (C) | 105. (A) |

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